The FOUNDRY

Volume 49
Number 11

Published
Semimonthly

CLEVELAND, OHIO, JUNE 1, 1921

Making Castings for Ice Machines

Air-Furnace Iron Low in Phosphorus Produces a Dense Gray-Iron—Complicated Castings Made Using a Number of Cores—New Malleable Foundry Contributes High Grade Castings

SOME firms even though they use a large tonnage of castings prefer to purchase them from outside concerns rather than manufacture them in their own shops. Others which have only limited requirements feel that it is preferable to make them in their own foundry. Still others produce some of the castings needed and secure the remainder from other firms. However, the disadvantage in this practice lies in the heaviest demand arising in boom times when it is difficult to secure castings and prices are excessive. Then delays are frequent. One large manufacturing firm greatly increased the use of malleable castings after it had established its own malleable foundry, where formerly the designing engineer did not know when he specified

FIG. 1—FLY WHEELS ARE MOLDED WITH SECTIONAL PATTERNS—CORES FORM THE SPOKES—NOTE THE ARBOR USED FOR ONE-HALF OF THE SPOKE CORE—THE WHEEL IS CAST AS A UNIT AND BROKEN IN TWO AFTER BEING TAKEN FROM THE SAND

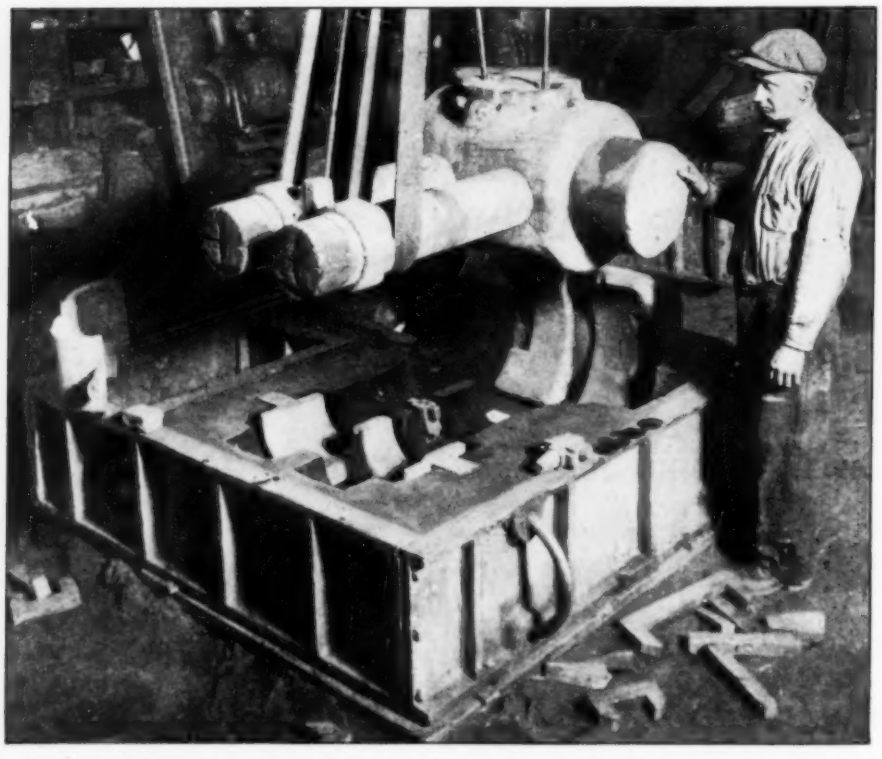


FIG. 2—THE COMPRESSER CASTING IS COMPLICATED AND REQUIRES A NUMBER OF CORES—THE METAL MUST BE DENSE TO PREVENT LEAKS

malleable iron for certain work but that there would be long delay in securing the castings. The firm owning and operating its own foundry can exercise a closer watch over the quality of the output and castings can be had to meet any unusual condition within the possibility of the art. These considerations and others which might be enumerated prompted the York Mfg. Co., York, Pa., years ago to establish its own foundries.

This company's product is ice making and refrigerating machinery, which requires castings with a dense structure, free from porous spots that might permit the compressed ammonia gas to escape. Cupola iron will suffice for some of these castings, but for others the denser air-furnace iron is required. Too, a large proportion of the castings must be made of malleable iron. To secure this variety of product the company has three foundries, although they are so closely situated, practically under the same roof, that one at first does not notice the divisions.

Store Flasks Under Cover

The first foundry is equipped with two cupolas and an air furnace and is devoted to the larger castings. The next has an air furnace for melting its iron, while the third is the malleable foundry and also is equipped with an air furnace. This third shop which just recently has been installed in a new building will be described in detail later. No. 2 foundry containing an air furnace is situated between the No. 1 plant and the malleable foundry. On one side of it the pig iron storage yard for the malleable and No. 2 foundry is situated. A section of the building in which flasks are stored is on the opposite side. The flasks are stored under cover so that they may be brought to the floor in the winter without digging them out of the snow. Further, laborers do not have to go out in the rain to get them, and the flasks rust less than when left exposed to the weather.

A second pig iron storage yard is located at the end of No. 1 foundry near the cupolas to provide a convenient supply for this shop. The charging platform for the cupolas is large enough so that five or six cars of pig iron may be stored on it. The chief chemist who has each car of pig iron analyzed in his laboratory sees that this platform is filled as nearly as conditions warrant. If any space is vacant on the platform when a car of iron is received it is taken directly to the charging platform instead of being piled in the yard. Pig iron is brought to the foundry in a battery truck, an elevator being used to carry it to the charging platform, where it still maintains its identity as parts of certain carloads. The chemist indicates to the charging boss by car number the amounts to be put in each charge. The charges then are made up on the charging floor as they are needed.

Safety Device on Cupola

Coke, received in cars, is dumped into a hopper and from here carried to a storage bin above the charging platform by a bucket conveyor. It is dropped into a charging bucket through a gate as needed.

A unique safety device is used in the cupola. This consists of a circular screen of steel wire attached to a wooden frame, covering the whole

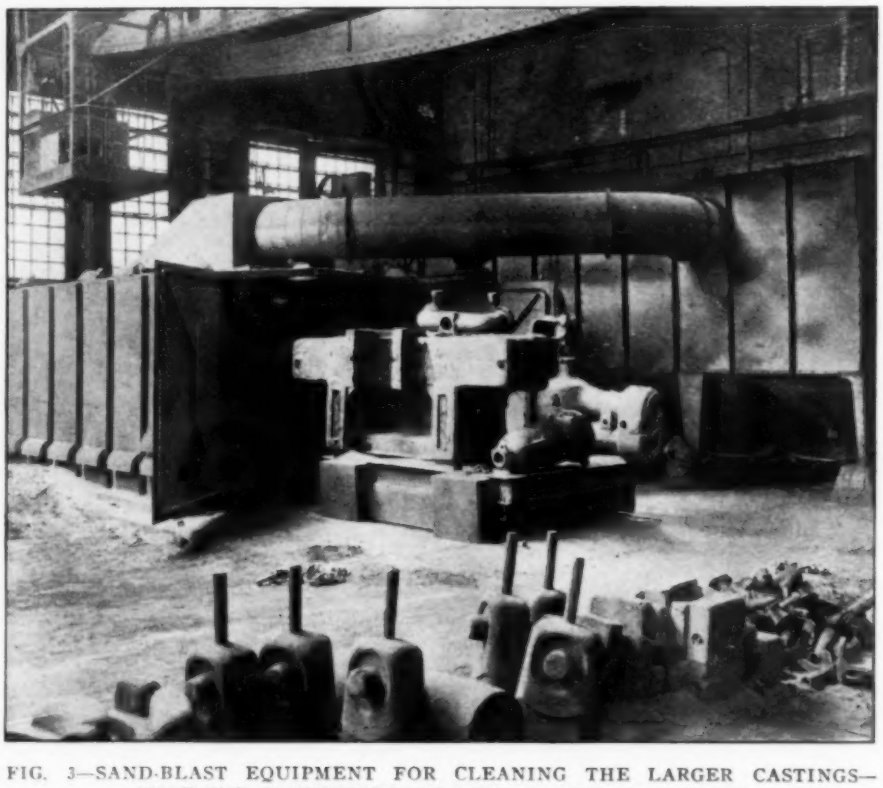


FIG. 3—SAND-BLAST EQUIPMENT FOR CLEANING THE LARGER CASTINGS—NOTE THE COMPRESSER ON THE FAR SIDE OF THE CAR

cross area of the cupola. The screen is divided into three segments. These are hinged in such a manner that the two end divisions may be folded over on the center, permitting the entire screen to be introduced through the cupola doors. It then is attached to the sill of the door by *U* braces which straddle the sill. A door in the screen may be raised to allow a ladder to be placed in the cupola and permit the cupola tender to enter the cupola. Then, after the screen door is shut, the cupola can be repaired without danger of any person carelessly throwing something in it or of loose brick falling on the workman below.

Furnace Operation

Usually only one of the cupolas which are lined to 54 and 66 inches in diameter respectively, is operated, and the other is held in reserve. The metal is carried to the molds by cranes with which the foundry is well equipped. The bay where the heavier castings are made is served by a 60 and a 20-ton crane, while the second molding bay is equipped with a 20-ton crane and the third bay by one of 15 tons capacity. Besides these cranes the cleaning room is equipped with a 40-ton crane and the heavy-core department has a 10-ton crane on one side of a double runway and one of 1-ton capacity on the other side. A number of small cranes also are placed in the shops devoted to light castings.

Practically every ice machine made requires a fly wheel so the foundry practice in making wheels has been thoroughly studied. A mold for a flywheel is shown under construction in Fig. 1. First a round hole is cleaned and a cast-iron socket for the spindle is bedded in the center. Then a coke bed about 3 inches thick is added and about 4 inches of sand is rammed on top of it. Two pipe vents on the outside of the mold are extended down to the coke bed, and the bottom of the mold is swept smooth and level. Cores for the arms, some of which are shown above in Fig. 1 are laid on the bed with the crane. These are made in two halves on arbors like the one shown at *A*, Fig. 1. First the lower half is set, then the upper half is lowered on it. The arbors have a lug on each side to serve for clamping the two halves together, as may be noted at *B*. A sectional core to form the lugs is set into the mold and the sectional pattern *C* is placed around the circumference covering the arc between two arm cores and sand is rammed between the cores and over them. A print *D* is used on opposite sides of the mold to form lugs which serve later to bolt the two halves of the wheel together. One section where the print has formed the lug in the mold is also indicated by *D*. These cores do not entirely separate the rim of the wheel so when cast the two sections are in one piece but joined only by a thin section. Cores in the hub separate it in two parts except at a thin section on each side. Four bolt holes in the hub and in the lugs at the rim are formed by cores.

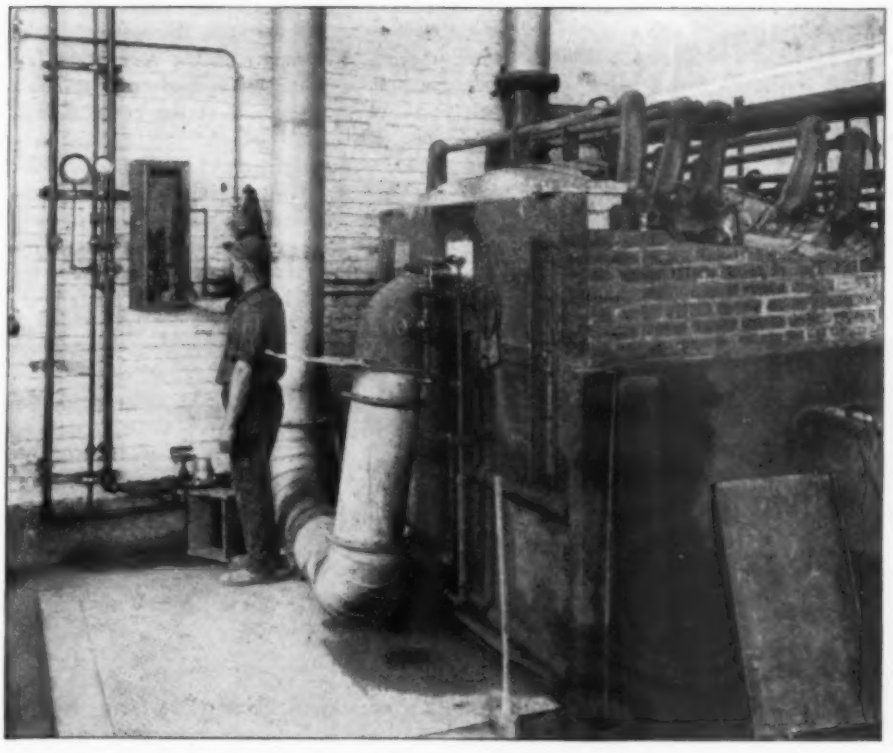


FIG. 5—ATOMIZED OIL IS USED FOR HEATING THE FURNACE MELTING MALLEABLE IRON—A LARGE VOLUME OF AIR IS SUPPLIED UNDER LOW PRESSURE

FIG. 4—AMMONIA FITTINGS ARE MADE OF AIR-FURNACE IRON AND ARE TESTED FOR LEAKS UNDER 300 POUNDS PER SQUARE INCH PRESSURE

Blacking Applied Dry

After the individual segments are rammed, the pattern is replaced and the outside of the mold is rammed. The surface of the mold forming the inside of the rim of the wheel is then blackened with plumbago applied dry with a brush. The inside of the cores are blackened with a plumbago wash before being

dried as is the usual custom, but the mold forming the face of the rim is not blackened, the iron being allowed to flow against the plain facing sand. This does not give as smooth a surface as though the mold had been blackened at this section but it is considered immaterial as this surface is later machined.

The portion forming the rim of the wheel is then covered with cores and after the center core is set and all the cores are weighted the mold is ready to pour. The metal enters the mold from four top gates on the hub and comes up in two risers and one flow-off gate on the rim, and two risers on the hub. The next day the sand is loosened and dug out around the casting and the following day the casting is lifted out of the sand and broken apart by wedges driven in the grooves, cored between the two sections of the hub and the two lugs on the rim.

The mold shown in Fig. 1 is for a 16-foot wheel which is one of the largest made by the York company, a 20-foot diameter wheel being the largest cast. The 16-foot wheel weighs 18,750 pounds. Molds for wheels up to 60 inches in diameter are made on a jolt machine.

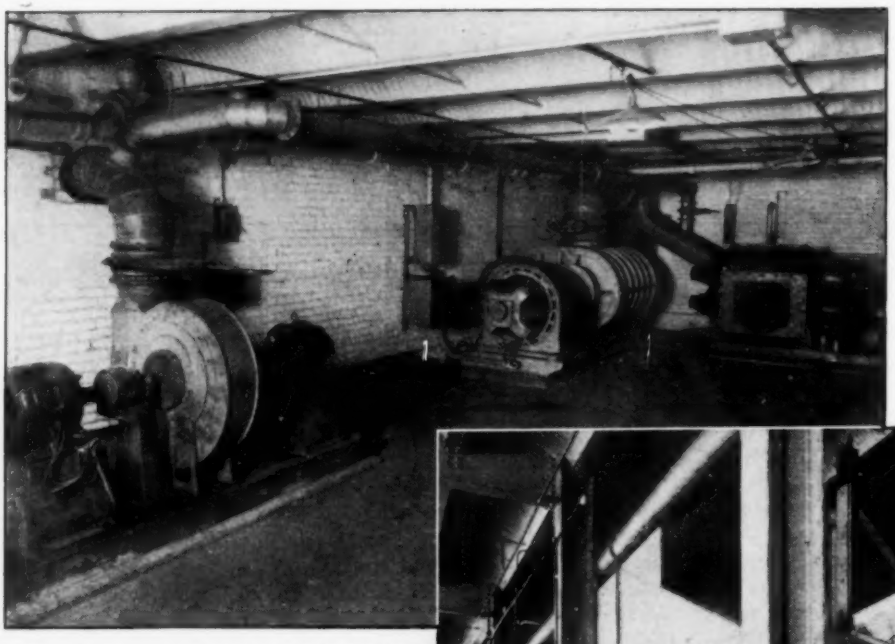


FIG. 6—BOTH STEAM AND ELECTRICALLY DRIVEN COMPRESSORS ARE USED

Make Complicated Work

Probably the most intricate and interesting casting made in this foundry is the machine base, outboard, bearing and compressor combined. A mold for one of these castings is shown in Fig. 2. As may be noted the large body core, being lowered into the mold by a crane, forms the compressor. The mold is made from a split pattern with the drag and the cope on separate boards. As may be noted, a number of cores are employed. The two to the extreme right are lightener cores to cut down the weight of the casting. The water jacket core is in two sections, one of which is shown set in its position in the mold at the extreme left. The other half of the jacket core may be seen resting on the edge of the flask to the left. A small inlet core for forming the opening for gas is shown lying on the flask to the right toward the front. One of these cores may be seen opposite it. The core for the shaft bearing is not shown. The corner at the extreme left is blocked off with two pieces of steel plate bolted to the flask. This serves to lighten the mold and lessens the sand required.

Extending from the building in which the heavy molding is done are the core room for heavy cores and the cleaning room extending parallel to each other. Sand is unloaded into a bin at the end of the core room and passed through a riddle. The sand is a Millville gravel with a considerable proportion of loam and so is found to require no milling and little binder. The binder which is used is a black pitch mixture. As has been said, the core room is divided into two parallel aisles, the one covered by a 10-ton crane and the other by one of 1-ton capacity. The cores are dried in two single-ended coke-fired ovens, being loaded and heated over night and taken out in the morning.

Fig. 3 illustrates the variety of castings produced in the heavy shop. The large base to the left is made from cupola iron but the other castings must all stand pressure tests and are made from air-furnace iron. Another characteristic of the iron put into the castings subject to the air pressure test is low phosphorus. The phosphorus is kept around 0.20 per cent and the sulphur below 0.05 per cent, while manganese is held at about 0.60 per cent. Silicon approximates 1.80 per cent in the iron from No. 1 air furnace which goes into the heavier castings, but for the smaller castings made from No. 2 furnace iron, the silicon is raised to 2.25 per cent. However, more than correct composition is necessary to insure castings which will not leak under pressure for it has been found that poorly designed castings will leak no matter what iron is used to make them or what precautions are taken in molding. A heavy section turning abruptly into a small section must be avoided.

A type of the casting made in No. 2 foundry from air-furnace iron is illustrated at the lower right-hand corner in

FIG. 7—THE ANNEALING OVENS ARE COAL-FIRED, FORCED DRAFT BEING SUPPLIED UNDER THE FIRE BOX

Fig. 4. This is a 2-inch return-bend ammonia fitting and must stand an air pressure test of 300 pounds per square inch under water. The molds are made in a 16 x 26-inch flask with a split pattern on a Mumford power squeezer. The drag and the cope are made from the same pattern. As may be noted from the cope at the top, Fig. 4, a large section of sand hangs with no support on the sides. To strengthen this sand six *soldiers*—wood blocks ¾-inch square by 4 inches long—analogous to gaggers are dipped in clay wash and inserted after a small amount of sand has been added in the flask. One half of one of the two cores which form the bolt holes in the flanges of the casting is shown at *A*, Fig. 4. The half cores are pressed into place and held with nails. In the cope shown in the same illustration no cores have been inserted but in the drag all cores are in place including the main body core which is in two sections pasted together horizontally. As may be noted from the illustration, the down gate is placed in the center of the mold and the metal flows to the core and along the core to the flanges. A portion of one of the gates may be seen on the casting at *B*, Fig. 4. Vents from each side of the core also are shown in the drag. A small strainer gate, *C*, Fig. 4, consisting of a 2½-inch disk core perforated with nine holes, 3/16-inch in diameter is placed at the bottom of the down gate.

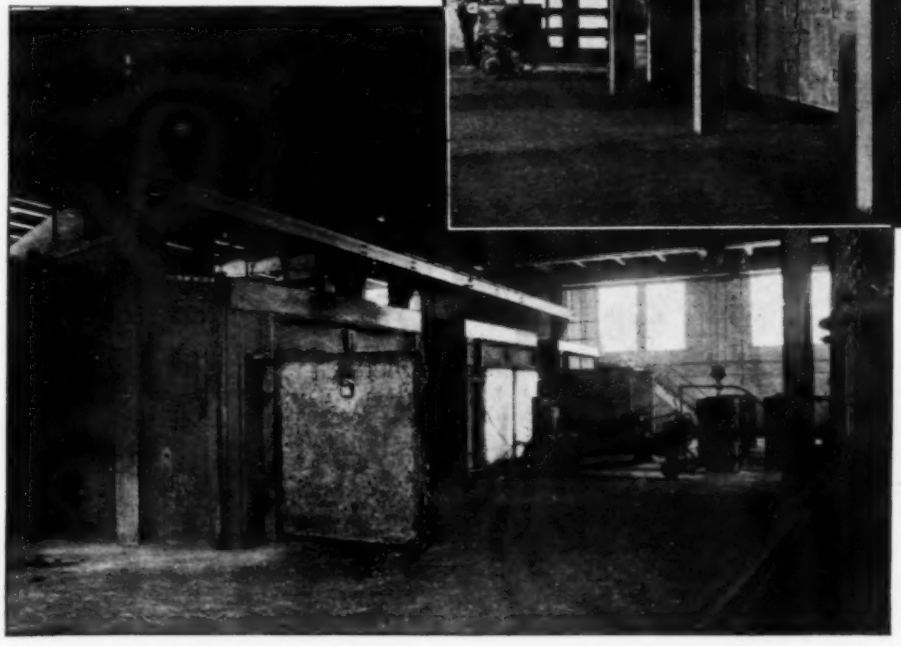


FIG. 8—WELL INSULATED ANNEALING FURNACES PREVENT THE RAPID LOSS OF HEAT AFTER THE FIRE IS SHUT OFF—NOTE THE PNEUMATIC CHARGING MACHINE

The air-furnace equipment of the York company as well as the operation of the furnace is extremely interesting. A 6-ton air furnace is used in No. 1 foundry where the heavier castings are made from both cupola and air-furnace iron. Smaller castings, mostly fittings, are made of iron from a 10-ton furnace in No. 2 foundry. Both of these furnaces are coal fired. One heat a day is taken from the smaller furnace and two heats from the larger furnace. It has been found that if the furnaces are carefully repaired over Sunday as needed, no trouble is experienced in operating them regularly through the week.

While coal-fired furnaces have been used for some time by the York Mfg. Co., the malleable air furnace burns oil. This furnace was built to burn coal but after a half dozen heats had been taken off it was decided to change to oil. The oil-burning equipment is shown in Fig. 5. The oil is under 40 pounds pressure and is atomized by a 30-pound current of air. This atomized oil meets a large volume of air introduced under 1 ounce pressure by a large pipe shown at the rear with the oil and the high-pressure air pipes beside it. A pressure gage for the low-pressure air is located in the box at which the melter is looking. Air-pressure and oil-pressure gages are shown to the extreme left. Beside the air entering at the rear, near the burner, a top blast also is used. Similar top blast is maintained on all of the air furnaces. The top blast pipes may be noted on the coal-fired furnace shown in Fig. 11.

Oil is used more as an experiment than for any other reason. A direct comparison now can be had between the two fuels. The advantage, of course, for the oil is that less labor is required to fire it but it has the disadvantage of higher cost. To melt a ton of iron in the oil-burning furnace 81.4 gallons of oil are required, while 0.598 ton of coal will melt a ton of iron from the coal-burning furnace. Taking the price of these fuels to the York company in January as $0.108 a gallon for oil and $7 per ton for coal the cost of fuel in melting with oil is $11.05 and with coal, $9.38 per ton.

FIG. 9—CORES ARE HANDLED ON RACKS BY ELECTRIC TRUCKS—THE SIX OVENS ARE OIL-FIRED

Labor Costs Low

Labor costs prove to be the reverse of the fuel costs. The direct furnace labor cost for the oil-burning furnace is considerably under the labor cost for the coal-burning furnace. The difference in labor cost is explained by the fact that only one man is required on the oil-burning furnace while two are needed to operate the coal-fired furnace and further by a difference in the rate of pay. Thus when the total costs for melting are considered for January it amounts to $11.05 per ton for the oil-burning furnace and $9.38 for the coal-burning furnace. However, this does not tell the

whole story as there is a difference in the cost of handling the fuel before it gets to the furnace which is in favor of the oil-burning equipment. Furthermore, the oil-fired furnace is much cleaner and neater.

This latter feature is especially noticeable. Neatness is one of the characteristics of the new malleable shop which has only recently been put into operation. This shop is a brick and fireproof building, part of which is three stories high. As has been said, it is located on the one side of No. 2 foundry. The pig iron for both the malleable and the No. 2 shop is kept in an angle formed by

FIG. 10—CASTINGS ARE STORED IN TWO ROWS OF TWO-HIGH BINS ARRANGED ON BOTH SIDES OF A LONG, NARROW ROOM

that part of the malleable shop which extends beyond the other building. It is stocked on separate piles and brought to the furnaces as needed on wooden skips carried by a battery car and charged into the furnace by hand. Steel is brought to the furnace in steel boxes and the sprue and scrap castings are taken directly from the floors to the furnaces without being rumbled. At one time all sprue was cleaned before being charged into the furnace, but no difference in the quality of the material has been found when using the uncleaned sprue so now neither the sprue for the malleable nor for the gray iron is cleaned.

All sprue in the malleable foundry is remelted and the remainder of the charge is made of pig iron and from 800 to 1000 pounds of steel scrap to the 6-ton charge. The metal produced meets the requirements of the American Society for Testing Materials specifications and the company holds a certificate from the American Malleable Castings association in evidence that all tests for three months came within the requirements of this specification.

It is thought that the main factor in the composition governing the strength of the metal is the amount of carbon in the white iron and an attempt is made to keep this between 2.35 and 2.45 per cent. Silicon is held closely to 0.90 per cent and manganese between 0.20 and 0.30 per cent. Sulphur is kept low, which is easy to do in an oil-burning furnace. Phosphorus is held to the standard requirements for malleable iron and kept a little under 0.20 per cent.

Two heats are poured each day; the one is finished just before noon and the other in the evening before quitting time. The laborers who shift weights dump the molds and temper the sand so that when the molders return after lunch and in the morning they can start to mold. These laborers also help to charge the furnace and at other times they grind castings.

Castings are taken from the molding department to the grinding and cleaning room beside the lower end of this department. The cleaning department is equipped with two tumbling barrels and four sand-blast barrels besides a sand-blast room with a rotatory table by which the castings may be loaded on the outside and carried to the sand-blast compartment. From the cleaning room, the castings are taken to the annealing department which is immediately adjacent. This department is shown in Fig. 8, in which the pneumatic charging machine may be noted. A 2-ton traveling crane covers the floor in front of the furnaces and assists in loading and unloading the pots as well as in moving the stacks about when the charging machine is busy. The three annealing ovens shown were designed by Enrique Touceda. One of the characteristics of the ovens is the thorough insulation of the walls, roof and doors. The benefit derived from the insulation is a saving in heat, but possibly more important than this is the slow cooling of the ovens after the fire is shut off. Although the furnaces have been in operation only a short time, it is found possible to cool the castings at the rate of not more than 4 degrees an hour. The doors are insulated with a light-weight brick and can be readily swung on hinges.

Coal Dumped Near Furnaces

A view of the rear, Fig. 7, shows the firing door over which is a ventilator to carry away the excess heat and any smoke given off while throwing coal into the fire pot. Coal is dumped from the cars into bins immediately behind the firing doors and is easily shoveled into the fire from there. The firing chamber is so designed with forced draft and a supply of air above the fire that it operates on the gas producer principle.

Each oven has its own stack composed of an outside and an inside section, both of steel plate. The gases from the furnace are carried in the inside stack which is 30 inches in diameter. These hot gases heat the stack and so form a draft in the space between it and the outer 36-inch shell. As this shell is not connected to the oven but opens to the room above the oven the draft carries heated air from the annealing room and this current of air between the two shells cools the inner stack; thus no brick lining is required.

The York company is extremely particular about maintaining the correct temperature in the ovens and has provided a thorough pyrometer system in connection with the ovens. A thermocouple is placed in the door and through the side of each oven. The couples of each oven are connected to a double recording instrument, and a 12-point selective switch allows the furnace man to throw any couple on an indicating instrument to check the recorder.

Blast is furnished to the ovens by a fan located in a blower room situated

next to the annealing department and near the air-furnaces in the malleable department and in No. 2 foundry. A view of this room, Fig. 6, shows two blowers to the right. The one at the extreme right is steam driven while the blower to the left is propelled by an electric motor. The engine for the steam-driven blower may be seen in part at the edge of the illustration. In the winter the steam-driven blower is used to furnish blast for the air furnace in the malleable-iron department and the exhaust steam is employed to help heat the building. The electrically driven blower furnishes blast for the furnace in

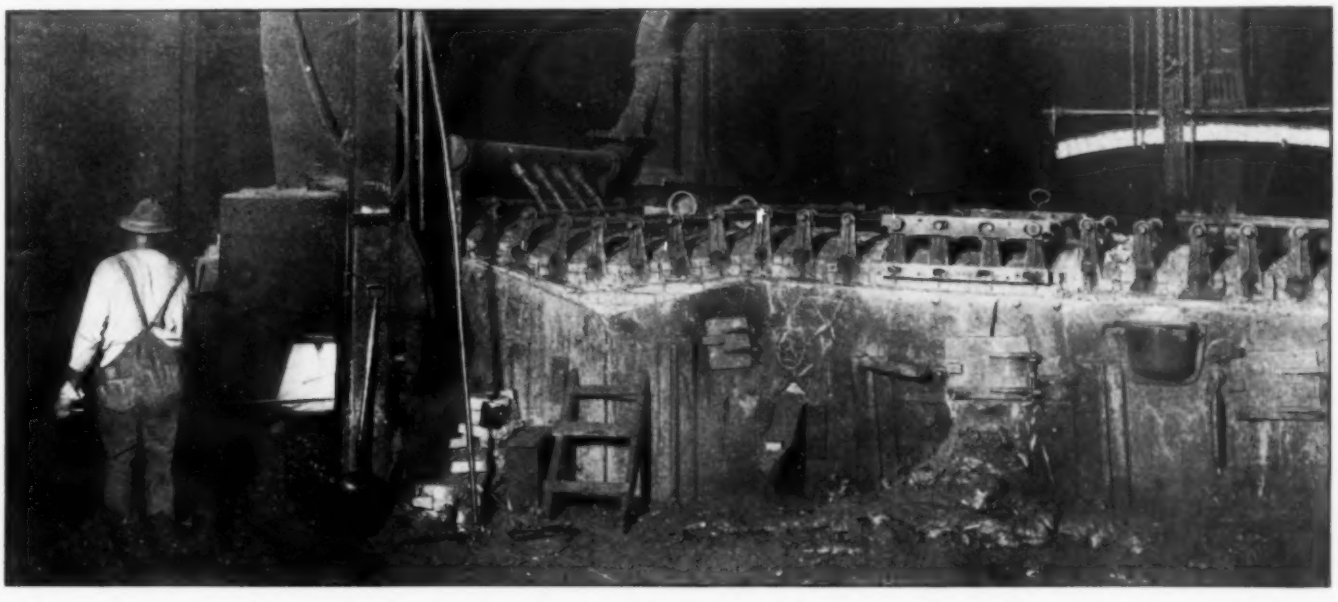


FIG. 11—TWO OF THE THREE AIR FURNACES ARE FIRED WITH COAL AT AN INCREASED LABOR CHARGE BUT A LOWER FUEL COST THAN WHEN HEATED WITH OIL

No. 2 foundry in the winter and for both No. 2 and No. 3 furnaces in the summer. The fan supplying the air for the annealing ovens is at the left, Fig. 6. As may be noted this fan is connected with a direct-current motor at the left and an alternating-current motor at the right. The flexible couple connecting the direct-current motor may be seen to the right. Either one or both of these couplings may be disconnected by pulling out the disk. The necessity for having a forced draft in the annealing furnaces at all times induced the company to take the precautions against stoppage by providing both the direct and the alternating current. Should both of these fail at the same time the blast still could be furnished, as the air duct is connected with the steam-driven blower.

It may be noted that the ceiling is quite low. This provides for a mezzanine floor on which a locker and toilet room with shower baths are located. On the second floor above this a similar room is located for the use of the core room employes who are employed on the second and third floors.

The core department is so arranged that the sand is brought to the third floor by a bucket conveyor. Here it is mixed and delivered to the coremakers on the second floor through chutes. One of these is located beside each coremaker's bench and delivers the sand to either bench through a butterfly valve. The cores are baked in a battery of six oil-fired ovens shown in Fig 9. A light with a reflector, as shown over the first oven to the right, will be provided for each oven so that the inside of the oven will be lighted when the doors are open. Cores are handled on racks transported by lift trucks now so generally employed in core rooms. Core sand is stored in the basement. It is dumped into bins from the railroad cars and raised from here to the third floor from whence it is dropped to any one of a number of belt conveyors running parallel to each other and covering the entire cross area of a room in the basement. The sand is swept off the belt at any point by lowering a baffle on to the belt at the desired place. With this system the sand may be spread over the room to an even height.

After castings are removed from the annealing ovens they are cleaned by tumbling and sent to a storage room consisting of a long aisle bordered on each side by a row of two-high bins. Two of the tumbling barrels with the fan and pipes of the dust collecting system may be noted in Fig. 10, at the back of which is shown the storage room. The safety precautions taken by the company are characterized by the screens and guards about the fan.

The heating system for the new malleable foundry is unique. Exhaust from the grinding wheels and the sand-blast system, after being purified, is blown through a heating box containing coils heated with exhaust steam and then blown into the rooms at various stations. The only expense in operating this system is the comparatively small maintenance cost and the operation of a fan to move the air.

Opens Columbus Offices for Sales and Service

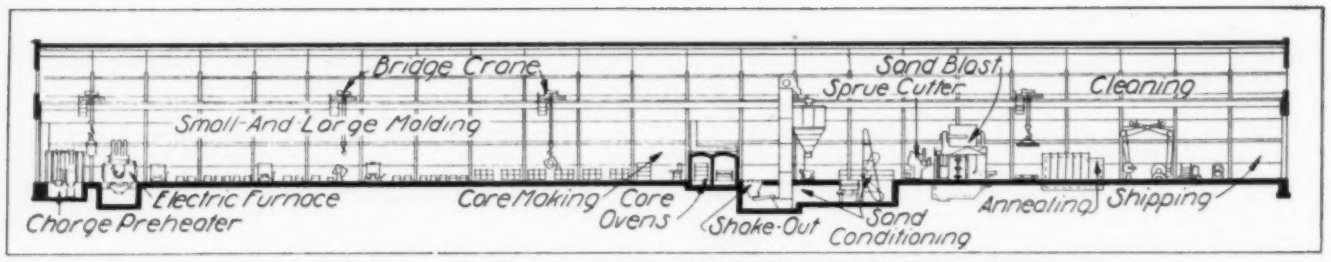
The Champion Engineering Co., Kenton, O., manufacturer of electric cranes has opened an engineering service and sales office at 326 Ferris Bldg., Columbus, O. R. W. Valls, vice president, is in charge of this office. Erwin B. Philips who has been works manager for some time has been made general manager at the main office and works, Kenton, O.

Publish Safety Posters

The Department of Labor and Industry, Harrisburg, Pa., recently has issued a number of striking bulletins or posters setting forth fundamental safety precautions to be observed in common manufacturing operations. The need for goggles is given particular attention. Clifford B. Connelly is the Pennsylvania commissioner who has charge of this work.

Joins New Organization

W. H. Gaylord Jr., formerly president of the Gaylord International Engineering Construction Co. and later sales manager of the McPhee Cement Co., has joined the Quigley Furnace Specialties Co., as assistant travelling sales manager in charge of the establishment of agencies for the company products.

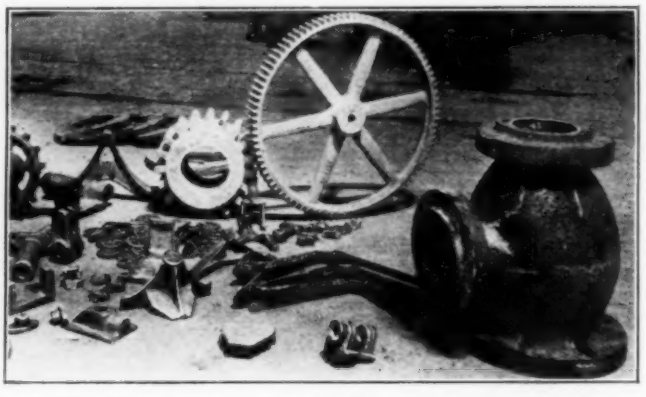


The Movement of all Material in a Straight Line Is Shown by This Sectional Elevation

Completes Revision of Foundry

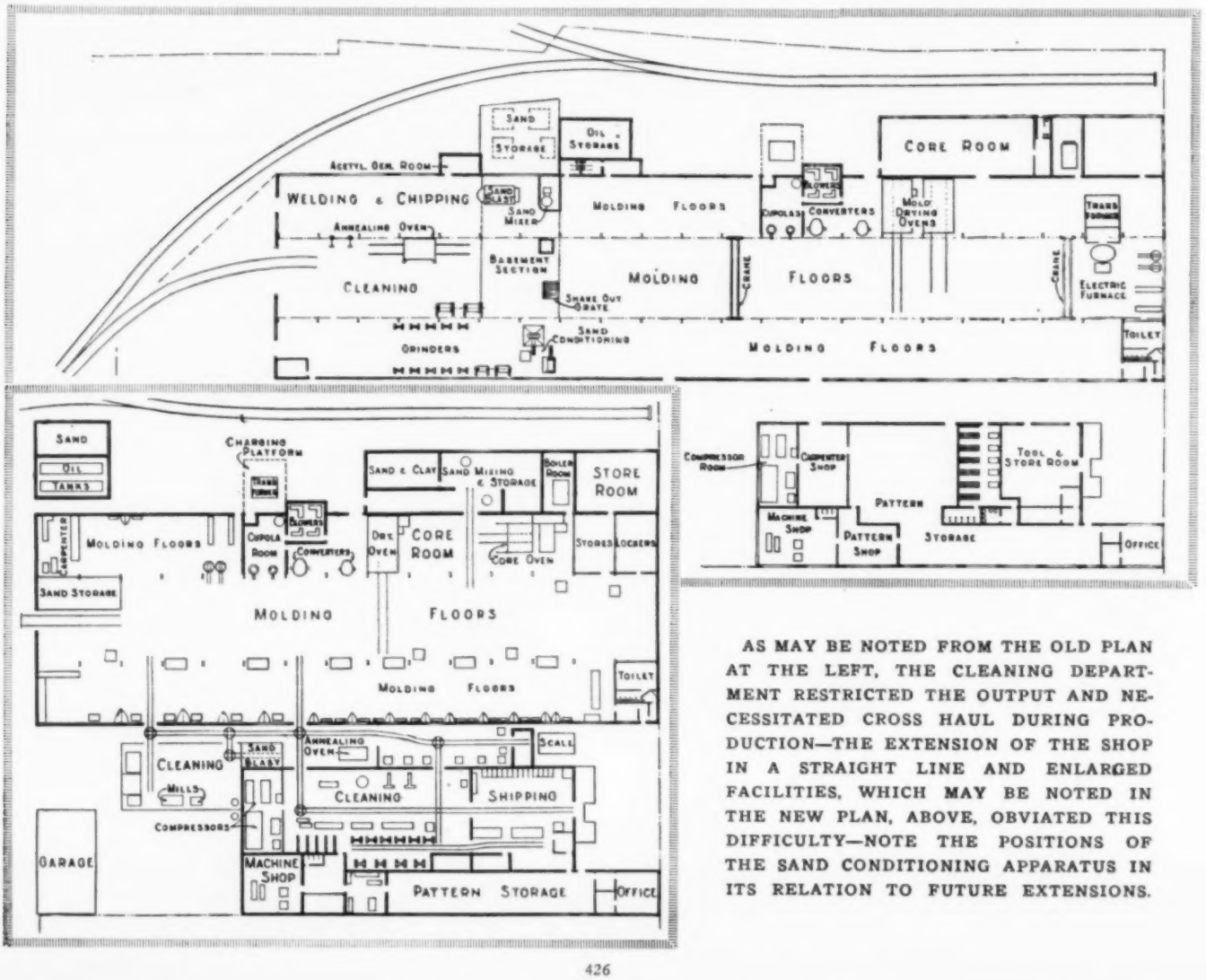
BY GEORGE H. MANLOVE

DEVELOPMENT of a straight-line foundry in which the iron enters at one end and travels steadily in the same direction and a process of making steel in the electric furnace, adding all alloys and completing the refining in the furnace, instead of depending on reactions in the ladle, sum up the accomplishment of the Chicago Steel Foundry Co., Chicago, in a recent remodeling of its plant. The work was carried out under direction of Frank D. Chase, Inc., Chicago.



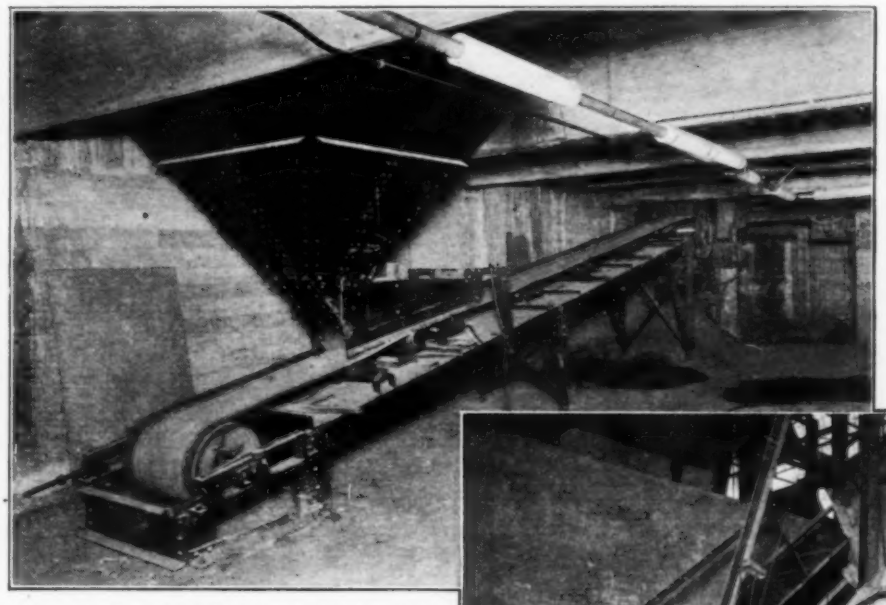
THE WIDE VARIETY OF CASTINGS IS EVIDENT FROM THESE TYPICAL EXAMPLES

The problem presented to the company was to utilize the plant it already possessed, a ground plan of which is shown at the left at the bottom of this page and to develop the entire property for an eventual production of 1000 tons of castings per month. In the old plant the molding area and molding equipment were sufficient for production of 315 tons of castings per month; but the



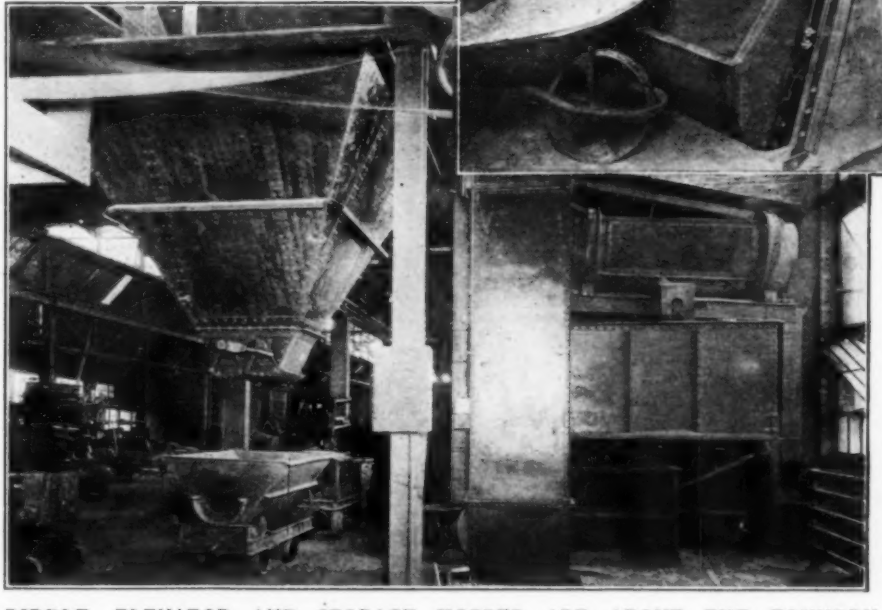
AS MAY BE NOTED FROM THE OLD PLAN AT THE LEFT, THE CLEANING DEPARTMENT RESTRICTED THE OUTPUT AND NECESSITATED CROSS HAUL DURING PRODUCTION—THE EXTENSION OF THE SHOP IN A STRAIGHT LINE AND ENLARGED FACILITIES, WHICH MAY BE NOTED IN THE NEW PLAN, ABOVE, OBVIATED THIS DIFFICULTY—NOTE THE POSITIONS OF THE SAND CONDITIONING APPARATUS IN ITS RELATION TO FUTURE EXTENSIONS.

capacity of the core room and core ovens was inadequate for this tonnage, and the cleaning department was entirely too small. The sand blasting and tumbling department formed a pocket which restricted free movement of the product



FROM THE SHAKEOUT GRATE, THE SAND IS PASSED OVER A MAGNETIC SEPARATOR TO AN ELEVATOR

from the shop. After sand blasting, it was necessary to carry the castings back through a 10-foot passageway between the foundry and the sand-blasting room to be ground, shipped and welded. The latter department was insufficient and caused much congestion about the grinders. Further the shipping room had no facilities for rail shipments and castings must be trucked 180 feet to railway cars to be hauled to the dump.



RIDDLE, ELEVATOR AND STORAGE HOPPER ARE ABOVE THE FOUNDRY FLOOR—BUGGIES ARE LOADED FROM THE HOPPER AS SHOWN

In developing the present plant, a modern cleaning building was erected and several other departments were reorganized, with the object of proportioning the various divisions so they would coordinate properly and so each could operate at its highest efficiency. Future expansion also was taken into account.

The new building is a continuation of the old foundry so that the craneway was merely extended; but the roof over the main bay is higher and provides better ventilation and lighting. The roof on the old building was raised to allow additional sash and to conform to the design of the new portion.

As has been noted the equipment is arranged to permit continuous movement of castings through the cleaning department from the foundry to the shipping area. Reference to upper plan indicates nature of changes in arrangement. The space formerly used by the cleaning and shipping departments has been utilized as a wash and locker room, space for general foundry storage, pattern storage, carpenter, pattern and machine shops. The core room has been rearranged to extend into the space vacated by the sand mixing department, and an additional core oven brings this department into balance with the remainder of the foundry, sufficiently increasing its capacity.

CORE AND FACING SAND IS PUT THROUGH A SPECIAL MIXER OR GRINDER BEFORE DELIVERY

Present plans look to an eventual capacity of about 1000 tons per month. As indicated in the plan, the present cleaning room is planned so it may be adapted readily to give greater molding area which will leave the sand conditioning apparatus centrally located. When this change is effected, the cleaning and shipping departments will be moved into a new building at right angles to the present structure.

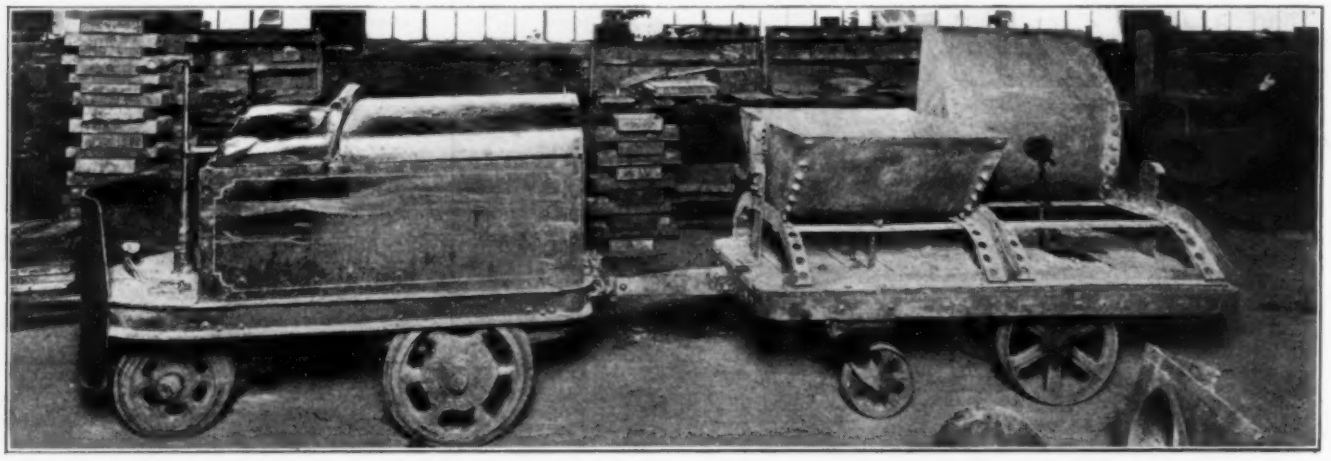
Several features in this plant are of particular interest. The first is arrangement of the molding floors to utilize the service of a tractor conveying sand from the sand hopper to one side of the molding floor in a specially designed dump car, which then passes to the op-

posite side of the molding floor and receives a load of sand and castings dumped from the flasks. This load is conveyed to the shakeout grate, and the train of dump cars returns with another load of sand. This loop gives service both ways and not only supplies the molders with sand but keeps their floors clear

the other three by the W. W. Sly Mfg Co., Cleveland. The castings then are carried to the sand blast, which is a combination table and room device for various sized castings built by the Hoevel Mfg. Corp., Jersey City, N. J. and then to the grinding machines, of which there are two swing grinders and 12 double

cated in the welding and chipping room.

Steel is produced in a 3½-ton electric tilting furnace, heated by three electrodes, using a three phase current. This furnace, which was made by the Industrial Electric Furnace Co., 53 W. Jackson Blvd., Chicago, has the three electrodes passing through a removable top or tilting roof.



SPECIAL BUGGIES WITH TWO LIGHT DUMP CONTAINERS FOR SAND ARE DRAWN IN TRAINS BY A STORAGE BATTERY TRUCK—A TRAIN OF THESE CAN BE HAULED

of molds and used sand. The dump buggies are equipped with two buckets, which will contain sufficient sand to meet the molders' requirements and further, are small enough to be handled by one man. The tractor used is the type made by the Mercury Mfg. Co., Chicago.

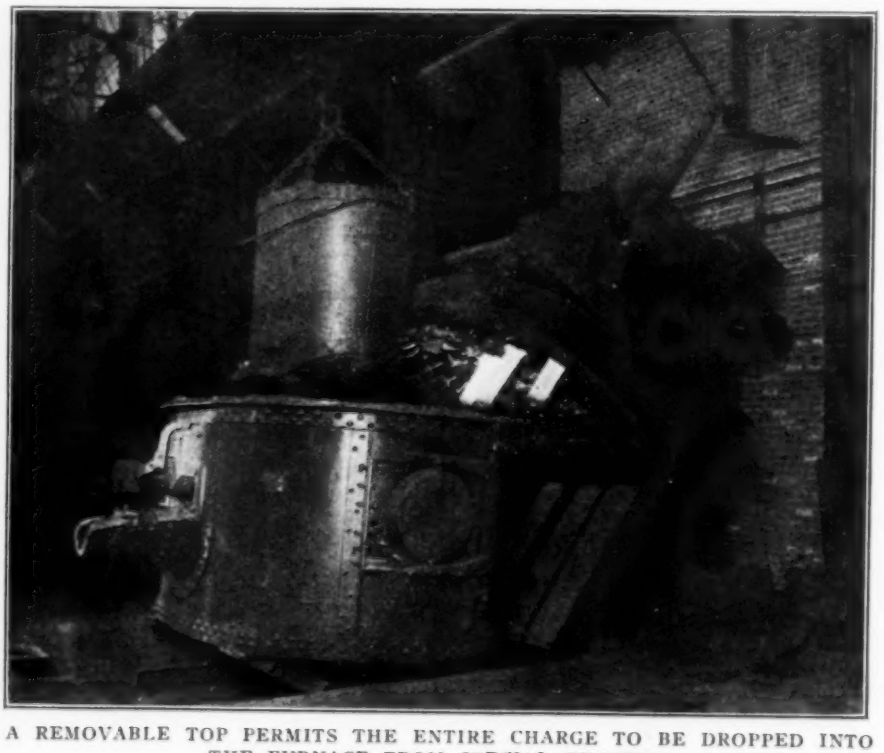
Another feature is the handling of sand. Extending across the foundry, at right angles to the line of travel of castings, is a subway beginning in the sand storage just outside the foundry walls into which sand is dumped by grab bucket through hatch covers. Storage for 35 cars of sand is provided. Just inside the building in the subway is a sand mixer with an elevator made by the National Engineering Co., 549 W. Washington Blvd., Chicago, which is used for mixing facing. Further along in the subway is a hopper into which sand from the shakeout grate is deposited. From this it is fed to a belt passing over a magnetic separator which removes all the iron. An elevator then carries the sand to the conditioning apparatus at the top of the foundry building where it is moistened and revivified and deposited in a 35-ton storage bin above the foundry floor. It then is dropped into the dump cars to be carried to the molding floors. The sand handling equipment was built by C. O. Bartlett & Snow Co., Cleveland.

On being separated from the sand, castings are passed through the cleaning department which is equipped with two large and two small tumbling barrels which are exhausted through the trunions. One of the large barrels was made by the Whiting Corp., Harvey, Ill., and

floor grinders. The swing grinders were designed by the company itself, and these with the stand grinders were made by the Safety Emery Wheel Co., Springfield, O. In this department the tractor has

another loop, leaving cars filled with castings ready for grinding and picking up cars on the other side of the machines in which ground castings have been deposited. An oil fired annealing furnace completes the equipment in this department, with the exception of that lo-

Electric current is secured from the central station at 12,000 volts and is passed through a 1500 kilovolt-ampere transformer, which steps it down to 180 volts for the furnace and through three 150 kilo-



A REMOVABLE TOP PERMITS THE ENTIRE CHARGE TO BE DROPPED INTO THE FURNACE FROM SPECIAL BUCKETS

volt transformers to reduce it to 220 and 110 volts for power and light.

The transformer room has been provided with every safety device possible to protect the equipment and machinery, as well as the safety of men whose work calls them into proximity to the current.

All leads have been heavily insulated and a special rack with heavy insulators carries all wires at an unusual height from the floor. The main switch is located conveniently and cuts off the current back of the transformer in case of any trouble. An auxiliary safety switch within easy reach of the furnace operator can be used to operate the main cutout switch without necessity of entering the transformer room. Copper leads from transformer to the furnace pass through a subway from the transformer room to the furnace pit instead of being carried overhead, as is customary.

The furnace is equipped with three 6-inch graphite electrodes made up of lengths screwed together and fed continuously as they burn. On starting the furnace the electrodes are regulated by hand for about 10 minutes, until a puddle of liquid metal has been formed and from then on control is automatic through a specially devised regulating apparatus actuated by motors connected to the furnace. In connection with this device, hand wheels allow clamps to be loosened on the electrodes for adjustment in placing new electrodes. These clamps, holding the electrodes, are water cooled.

The furnace is charged by a bucket with a drop bottom which places the entire charge at one operation instead of its being shoveled through the side doors. This results in a great saving of time. Provision has been made for installation of a preheating device to use crude oil, which will bring the scrap to a red heat before it is placed in the furnace, thus greatly reducing the time of melting. Heats have required about 1½ hours in actual practice, but this has not been under pressure for time and probably could be shortened.

The capacity of this foundry is about 700 tons of completed castings per month. While the average weight is about 11 pounds, the work ranges from one ounce to 5000 pounds, although nothing heavier than 3000 pounds has been cast up to this time. In the foundry molds are made by air squeezers manufactured by the International Molding Machine Co., 2614 West Sixteenth street, Chicago, and by jolts for heavy floor work. The heavy machines were made by Henry E. Pridmore, Nineteenth and Rockwell streets, Chicago. The full length of the foundry and shipping room is 340 feet and three 5-ton cranes span it, one made by the Whiting Corp. and the other two by the Northern Engineering Works, Detroit.

Make Physical Tests

A laboratory has been provided with a tensile testing machine, coupons being cast from every heat and careful test being made for record. In the chemical laboratory various determinations of carbon and other constituents are made on each heat.

Only one test is taken before final pouring, unless some condition arises which makes it necessary to take a second. A test piece is cast and broken and the carbon is judged by the fracture to indicate the general condition of the steel. A laboratory analysis is then run before the metal is poured. The heat number is stamped on all castings for future identification.

By using delta or star connection voltage can be varied from 180 to 90 volts, the former being used for melting and the latter for refining. On the average the furnace is run at about 4500 amperes and 175 volts. The average consumption of current is about 600 kilowatt hours per ton.

All additions of alloys are made in the furnace before the metal is poured and the entire refining process is completed there, the final condition of the metal being determined by testing before it is removed from the furnace instead of making additions of alloys in the ladle.

After being poured from the furnace the metal is taken by a crane direct to the molding floors. While the capacity of the furnace is 3½ tons, this is frequently exceeded by as much as one ton per heat. The process in this foundry is practically continuous in that molds are poured whenever the furnace is ready to discharge its heat and making of new molds continues meanwhile. As soon as the molds have cooled sufficiently they are dumped from the flasks into the dump cars and removed to the shakeout floor by the tractor system already mentioned.

The Chicago Steel Foundry was the first steel foundry in Chicago and has been in operation about 15 years. In that period it never has been shut down three consecutive days, except when Saturday and Monday holidays occurred.

Decide on Acid or Basic Furnace Lining

BY F. W. BROOKE

ONE of the first things to decide on installing an electric furnace is whether to line it with an acid or a basic material. So many points must be considered in making the decision that a concise statement of the advantages and disadvantages of each would help to a clearer estimate of each process. Briefly, acid operation is favored when:

1—The sulphur in the scrap is and *always will be* less than the sulphur required in any castings you will be required to make.
2—The phosphorus in the scrap is and *always will* be less than the phosphorus required in any castings you will be required to make.
3—When the range of carbon and silicon contents will always be wide.
4—When power consumption and rate of operation are of prime importance.
5—When very small castings are the sole output.

The author, F. W. Brooke, is vice president, Electric Furnace Construction Co., Philadelphia.

Basic operation should be adopted when:

1—The sulphur in the scrap now, or in the future, may go above the limits required for chemical or physical tests or requirements.
2—The phosphorus in the scrap now, or in the future, may go above the limits required for chemical or physical tests or requirements.
3—When the steel has to be made to a close limit of carbon, silicon or manganese.
4—When alloy steels are ever to be made in the furnace.
5—When steady load is essential.
6—When refining of cast iron is being considered.

Reasons 1 and 2 Acid and Basic: a prospective purchaser of an electric furnace, in looking over his available scrap supply, often feels he can obtain all the scrap he requires of a sulphur and phosphorus content low enough, say below 0.04 per cent, to meet his requirements. The scrap market and the freight situation, it has been our experience, only too often upset his calculations, and he is confronted with the problem of having scrap with high sulphur and high phosphorus and a furnace which cannot eliminate these all-important injurious elements. It has often meant one of three things: Paying an excessive price for low-sulphur and low-phosphorus scrap; a shutdown until proper scrap can be obtained; or bad castings and a dissatisfied customer. Let us assume that this situation can be satisfactorily met. There is still the subject of requiring a low sulphur for special occasions. This can only be produced in a basic furnace as phosphorus cannot be reduced on an acid bottom.

Reason 3, Acid and Basic: It is easier to control the carbon, silicon and manganese in the basic furnace, which means that where specifications have to be met the rejections are apt to be less, particularly on physical tests, such as a good relation between the maximum

stress and yield point, and a good elongation with a relatively high maximum stress. Refining can be done in the acid furnace to a limited extent, but calls for skillful operation.

Reason 4, *Acid*: The acid operation gives a better power consumption in the relation of about 100 to 112, because there is little time taken for refining in the acid operation. It also gives a lower cost for refractories as the cost of raw refractory material is less and the repairs are less frequent.

Reason 4, *Basic*: If alloy steels are ever contemplated, a basic furnace is desirable. Manganese steels, for instance, so often required in the steel foundry industry, can only be economically made in the basic furnace. The use of other elements, particularly chromium, vanadium, etc., can more advantageously be handled in the basic furnace, and while the making of alloy-steel castings may not be of immediate consideration, their use is becoming more general, especially for parts requiring uniform wearing qualities, resistance to shock and to alternating stresses.

Reason 5, *Basic*: A basic furnace invariably has a steadier load than an acid furnace, for two reasons:

Higher secondary voltages are used in the acid to bring about more rapid melting.

The resistance of an acid slag is higher than the resistance of a basic slag, and therefore also requires a higher voltage.

Both of these reasons calling for a higher secondary voltage causes in practice longer arcs and higher surges because the electrode travel cannot pick up as rapidly.

Reason 5, *Acid*: In making small steel castings, three important points must be kept in view:

Do not have the furnace of too large a capacity—install smaller units and more of them; for instance, when the castings do not exceed 10 to 15 pounds a 1-ton furnace should be the maximum.

Hot metal is essential, because of the necessity of pouring into shank ladles where the transfer losses and the ladle losses are high, and because of the number of pours required.

It must be easy to hold back the slag and acid slag will keep back and separate more readily than basic slag.

This does not mean that small castings cannot be made of steel from the basic furnace, but it means that in foundries where castings weighing ounces and a maximum of say 25 pounds are to be made, the acid operation is easier and more economical, providing, of course, that the other clauses can be met satisfactorily.

Reason 6, *Basic*: Probably the latest field for the electric furnace in the foundry is the refining of gray iron. This is particularly applicable to the making of engine cylinders, high-pressure valves, piston rings and parts requiring uniform wearing qualities, etc. The practice now being adopted is to pass the molten pig iron from the cupola through the electric furnace for a refining period of 20 to 40 minutes, which gives a rapid desulphurization; elimination of occluded gases, and an accurate pouring temperature. Owing to its ability to reduce sulphur in the metal the basic furnace is the better adapted for refining gray iron.

New England Companies Merge Interests

Details have been announced of the merger of the Baldwin Chain & Mfg. Co., and the Arcade Malleable Iron Co., both of Worcester, Mass. The stock interests of the two concerns have been practically the same since last year when the former secured a controlling interest in the foundry company, a necessary adjunct to its business. The combined capitalization which was $148,000 has been increased to $1,050,000, consisting of $300,000 first mortgage bonds and $750,000 in common stock.

The former officers of the Arcade Malleable Iron Co. will hold the same offices in the consolidated company which will do business as the Baldwin Chain & Mfg. Co. As the business of each company will be continued separately on the same basis as previously, with the additional foundry facilities, secured by the recent purchase of the adjoining property of the Richard French Iron Works, the management of the Arcade plant will remain unchanged with H. P. Blumenauer continuing as general manager, A. L. Scott, sales manager, and John Jordan, plant manager.

The officers of the reorganized companies are: President, George T. Dewey; vice presidents, William F. Cole and James H. Kendall; treasurer, William H. Gates; general manager, William A. Rockenfield. The merger brings under one head two of the most important industries in Worcester. The foundry company has been in existence many years, having been operated by George B. Buckingham and his son, H. Paul Buckingham, both now deceased.

The New York, New Haven & Hartford railroad has reduced rates on sand and gravel approximately 25 cents a ton on a mileage basis. It is understood other New England railroads will apply for authority to make reductions.

Welding Hose Colors Are Given Attention

To define their stand in the question of changing the identification colors for oxygen and acetylene hoses and regulators the executive board of the Compressed Gas Manufacturer's association recently passed a resolution as follows:

"Resolved, whereas, although it would have been a good thing for the industries if red had been adopted as the color for combustible gases at the inception of the business, grave results might follow such adoption at this time, we therefore feel that it is desirable to go on record as against changing colors now in general use."

The movement was in accordance with that made by the National Board of Fire Underwriters which in its 1910 edition of rules and requirements states:

"In order to avoid confusion when attaching the hose to the connections a red colored hose should be used for oxygen and a black colored hose for acetylene."

An attempt was being made to have the order reversed on the ground that red should denote the hose carrying the most dangerous gas.

Will Make Pneumatic Accessories

The H. O. King Co., engineers and tool makers, last January acquired the interests, patents and patent rights of the Duntley Pneumatic Tool Co., Chicago. At the time Mr. King organized the Duntley-King Pneumatic Tool Co. for the production of pneumatic tools and accessories. The new company now is in production with general offices and factory at 1143-45 Diversey Parkway, Chicago.

Completing New Foundry

American Metal Products Co., Milwaukee, is completing a new foundry equipped with electrical melting units in which a new product will be manufactured. This new product is a bronze which will contain approximately 5 per cent aluminum, 13 to 50 per cent steel and 43 to 70 per cent copper, with an amalgamating alloy. The new bronze is said to be bright yellow in color and to have a tensile strength of over 68,000 pounds per square inch. Its sclerescope hardness is given at 28 to 45 points depending upon the grade. The metal is recommended by the company for drawing, forging and for bushing or bearing manufacture. Tests are being made upon this metal in service in bushings which are run dry.

Propeller Wheel Mold Standardized

By Employing Accurately Fitting Flasks and Rigging Propeller Wheels True To Size and Pitch Are Turned Out in About One Tenth of the Usual Time—Detailed Moldings Are Described

BY ENRIQUE TOUCEDA

FOR a number of years prior to the world war the firm of George H. Thacher & Co., Albany ,N. Y., was engaged in the manufacture of marine and other gray iron castings. At the outbreak of the war the firm decided to specialize in the manufacture of propeller wheels. While preparing to solve the problem two distinct factors were kept in mind. The first was to devise an economical method for producing a perfect wheel and the second was to meet the insistent demands of the shipbuilders for an ever increasing number of wheels in the shortest possible time.

In ordinary practice two general methods of manufacture are employed the shortcomings of which have been freely acknowledged. In the sweep method, the nowel, or bottom half-mold, for each blade is swept up by a spindle beam and pitch race, while the top half-mold for each blade is built up individually. In the pattern method one individual blade, with the hub or hub portion, is mounted on a spindle and the individual blade mold formed, the pattern is then rotated on the spindle to the position for the next blade, etc. In rare cases wheels were made from a complete pattern. Owing to the cost of the pattern, its failure in many instances to be correctly made, and (when made of wood) its early and sure distortion the disadvantage of this practice is obvious, while metal patterns in most instances are prohibitive in cost. In these methods both green-sand and loam molding are practiced. The back surface of each blade must be chipped to a templet to such accuracy as will be required for a static balance. Inasmuch as the work done by the machine tool is confined to the driving face of the blades, not only is perfection difficult to attain, but corrosion will be greater because of the removal of the dense skin of the casting and the local strains set up by the pneumatic tool in chipping.

To produce a finished 9-foot propeller for a navy destroyer required from 8 to 21 days of foundry work and about the same length of time for the machining. Through the use of the Thacher process, only as many hours are required, besides it is possible to produce a finished casting in perfect conformity with any particular propeller-wheel design. The method is fool-proof against inaccuracy for each part of the mold is contained within and supported by a cast-iron casing, or container, the dowel pins of which are fashioned to engage accurately the holes in the casing or bedplate to which it is to be attached. So accurately made are the various parts of the cast-iron flask that, in the case of flask and mold equipments covering certain limiting diameters and pitches of wheel, any part of one outfit is interchangeable with the same part of any other sim-

From a paper to be presented at Wilkes-Barre, Pa., September, 1921, before the Institute of Mining and Metallurgical Engineers. The author, Enrique Touceda, is consulting engineer Albany, N. Y.

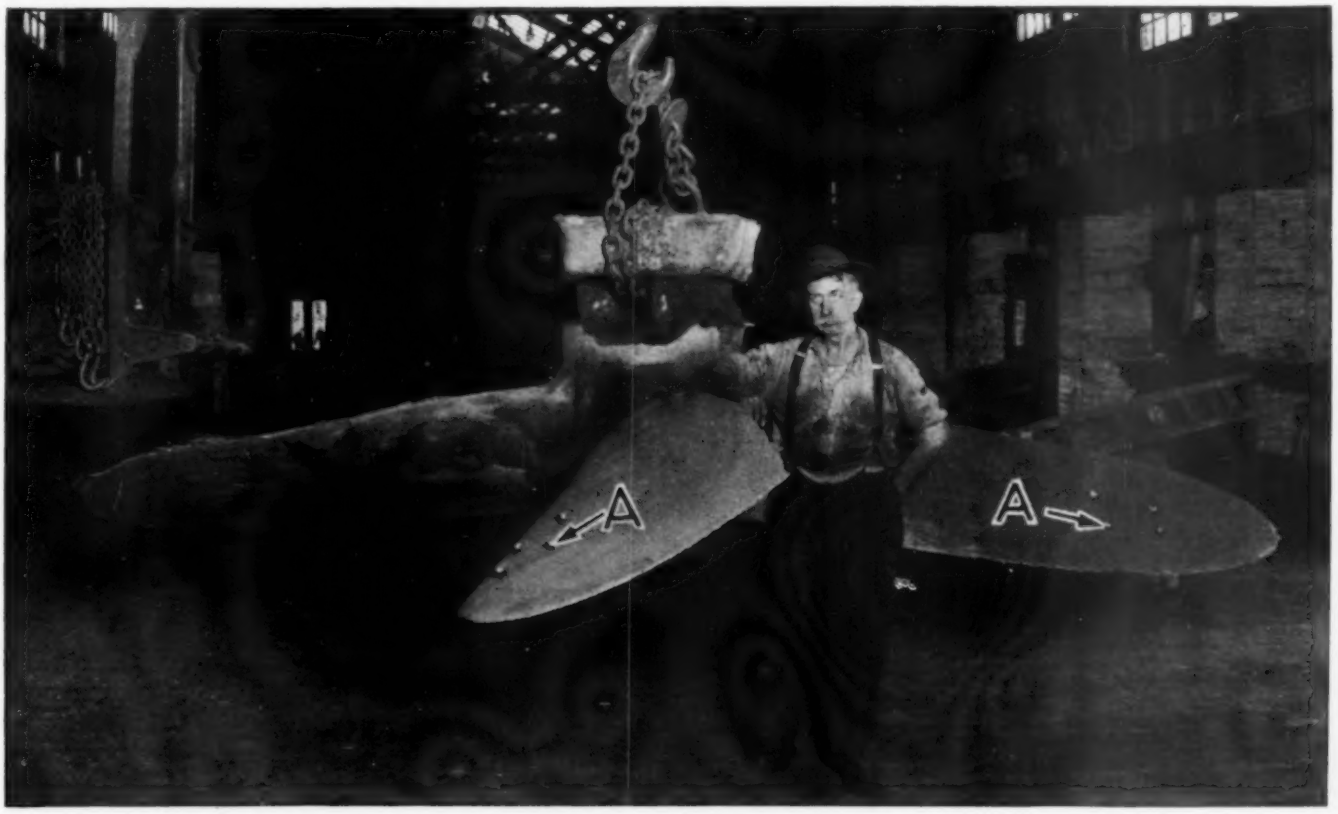


FIG. 1—FOUR BLADE SEMISTEEL WHEEL JUST OUT OF THE MOLD THE STUMPS OF THE POP GATES MAY BE SEEN AT *AA*

FIG. 2—ASSEMBLED MOLD WITH POURING RING IN POSITION

ilar outfit. A perfect propeller wheel was cast in a foundry just outside of Boston from a completely assembled mold made up in Albany that was shipped, uncrated, by ordinary freight.

Equipment Required

The equipment necessary for the molding of a propeller wheel consists of: (1) base or assembly plate, (2) templet or jig, (3) nowel pattern plate, (4) cope container, (5) nowel pattern block, (6) cope pattern block and blade pattern 6-*A*, (7) nowels or drags (one for each blade), (8) copes, (9) center plate, (10) center arbor, (11) arbor cap, (12) pouring ring or basin.

The base plate, nowel plate, cope container, nowels, and copes are built sufficiently heavy to eliminate spring or twist. The base plate is permanently located in a pit on the foundry pouring floor. The nowel plate, container, copes, and nowels have suitable adjustable trunnions for rolling over in the molding operation. The copes and nowels are provided with adjustable sand-carrying bars to accommodate variations in pitch requirements and are adjustable to either right-hand or left-hand wheels. The pattern blocks are built to standard pitch and are usable for wheels of the same pitch with varying diameter within the equipment capacity by simply changing the blade form 6-*A* shown on the cope pitch block 6.

For small wheels, the base or assembly plate is a round iron casting, the top surface of which has been machined to a true plane; in the largest sizes, it is made in two or three parts. A hole is drilled in the center by means of which the jig used when drilling the holes for the flask assembly is located. This base is shown in Fig. 1.

The jig is built from a drawing and is machined and drilled to the finest possible exactitude. It is used as a master jig particularly for locating holes in the base plate, nowel pattern plate, cope container, nowels, and copes. It is made of cast iron and is machine finished to a true surface. It is drilled for attaching to the nowel pattern with locating holes from the jig for positioning the nowels.

The cope container 4, Fig. 4, is built up of cast iron preferably on a machine-finished cast-iron plate with two sides and the blade set on the draft angle. The hub end may be set at an angle of 90 degrees, for a four-blade wheel, or 120 degrees for a three-blade wheel. These ends and sides are bolted, through machine-finished flanges, and the top flanges are planed to a true surface parallel to the bottom-bolted plate (which has been previously drilled for attaching the pattern). Locating holes are drilled in the top flanges from the jig for positioning the copes. The inside volume or space in the container is equal to the combined volume of the nowel pattern block and cope pattern block, before separating.

Nowel Pattern Block

The nowel pattern block 5, Fig. 4, is built of suitable pattern wood on a machine-finished plate with spindle, arm, and race for generating the desired pitch on the face. The nowel pattern, at the base, is the same shape as the large end of the container with drafted sides and tip end is on the angle for draft. Usually the taper is 1 inch per foot height. The hub end

FIG. 3—SHOWING METHOD OF LAYING OUT FLASKS ON CENTER PLATE

is cut at an angle of 90 or 120 degrees at the center line. After the block is built of the desired dimensions, a top deck of mahogany, cherry, or other suitable wood is put on and swept down to the true pitch designed and the cope pattern block is built thereon.

The cope pattern block 6, Fig. 4, is practically similar to the nowel pattern block, as it is built immediately thereon with its contacting surface matched to the true pitch deck of the nowel pattern block. This block construction is then carried on until the two blocks represent the inside area, shape, etc. of the container 4. The nowel and cope blocks are separated on the pitch plane so that each block has an accurate true pitch plane surface. A portion of the hub and fillet is attached to the nowel block 5 and a portion of the hub, fillet, and complete blade pattern 6-*A* is attached to cope block 6. The nowel pattern block 5 is then ready for attaching to the nowel pattern plate 3 and the cope-pattern block 6 is ready to be dropped into the cope container 4 and attached to the bottom plate.

The nowels, or drags, 7, Fig. 3, are solid one piece castings. They are rectangular except for one open end, which is angular (as in container and nowel plate). They are open at the top, or joint side, to set over the pattern, with cross bars at the bottom for sand carrying and strength. The top and bottom have heavy flanges, which are machine finished in parallel planes; the locating holes are positioned therein from a jig.

The copes 8, Fig. 3, also are one-piece flasks. Their general construction is similar to that of the nowels. They have heavy ribs spaced at suitable intervals and the top and bottom flanges are machine finished in parallel planes. The holes are located from a jig.

The center plate 9, Fig. 6, is a small cast-iron circular plate, machine finished over its entire surface, with a boss at the center of the under side for positioning on the main assembly plate 1 and a center hole in the boss for the insertion of the center arbor 10. On the upper side of the plate 9 are projections for holding the core sand.

The center arbor is a hollow iron casting with two turned end bearings for carrying center core 10, Figs. 3 and 6. It is set into the center plate 9 and is centered at the top in the arbor cap 11, Fig. 6.

A cast-iron ring with the center attached by brackets at the top forms the arbor cap 11, Fig. 6. It is dropped over the center arbor 10 and on to dowels for positioning on the copes 8. It is filled with sand and serves as a cover for the hub. The sand is cut out to form a basin and several feeding risers on the hub.

The pouring ring in Fig. 2, is a circular cast-iron trough into which metal is poured, in order that it can flow through the gates to each blade mold. The metal enters each blade through the lower outer extremity, unites in the hub, and rises up through the hub riser until sufficient head is established to insure solidity.

After the base or assembly plate 1 has been placed on the foundry pouring floor, the nowel pattern plate 3 with the pattern block 5 is set on a substantial floor. The nowel 7 is placed over the pattern on the plate and is bolted to the plate through templet holes in both. It should be remembered that the face of the pattern plate and both top and bottom flanges of the flasks are accurately machine finished, in parallel planes, so that with the nowel in position and bolted to the pattern plate, the bearing flange face of the nowel is in perfect contact with the pattern plate. It is not possible to enter the finest gage between the contacting surfaces. The pitch plane on the pattern is therefore definitely located inside of the nowel, with relation to the contacting surfaces and the guide pin holes.

A suitable, strong, dry sand facing is riddled on to cover the pattern block. A weaker dry sand mixture then is evenly rammed or tamped, until the nowel is full and butted off even with the cross ribs and flanges. A machine-finished cast-iron, perforated, plate is bolted on to the nowel bottom and the nowel and nowel plate are rolled over and deposited on a core-oven truck. The nowel pattern plate, then is unbolted and drawn off, using guide pins. The nowel then is ready for baking. The nowel plate is replaced on the floor and the second nowel is placed in position and bolted thereon. It will be observed that by this procedure the pitch plane of the pattern has been transferred from the drilled and planed surface of the pattern plate to a similar fixed location with relation to the planed nowel flange surfaces.

The same operation is conducted in the molding of the copes. While the

FIG. 4—COPE CONTAINER OR FALSE DRAG ENCLOSING COPE PATTERN BLOCK AND BLADE PATTERN FIG. 5—NOWEL PATTERN PLATE AND NOWEL PATTERN BLOCK

description indicates that the copes are molded after the nowels, the two operations would naturally proceed at the same time, one gang of men working on nowels, and a second gang making the copes. In the case of a 9-foot, three-blade, destroyer wheel, or similar wheels up to 12 feet in diameter, with both cope and nowel production as described, the average molding time would not exceed 5 to 6 hours. The mold is baked for from 16 to 18 hours in an ordinary core oven at temperatures from 360 degrees to 420 degrees Fahr. (182 degrees to 216 degrees Cent.), after which it is ready for assembling.

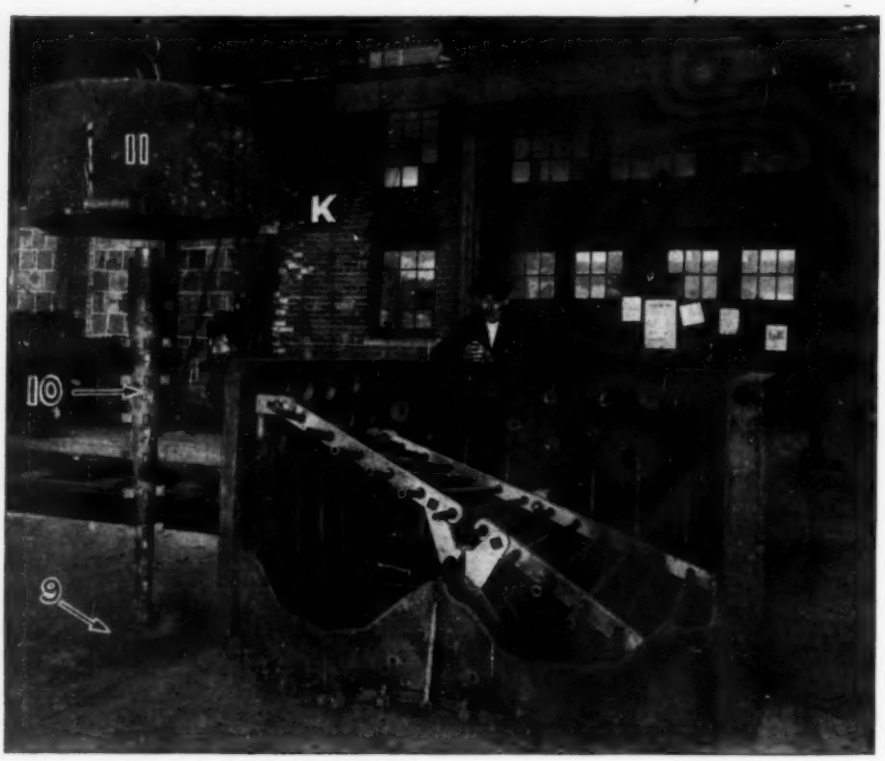


FIG. 6—TYPICAL NOWEL OR DRAG FLASK, CENTER PLATE, CORE ARBOR AND ARBOR CAP

The assembly plate is thoroughly cleaned and each successive baked nowel is placed and bolted in position, as fixed by the jig. The baked copes are successivly placed on the nowels and similarly bolted, the center plate 9 being lowered in place in the center hole of the assembly plate and the joints between the copes and the nowels are closed through the top opening by the use of slurry or lead paste. The center arbor 10 is entered into the center plate 9, the arbor cap 11 is set over the center arbor 10, and the pouring ring, Fig. 2, is set on the copes and made up; the mold is then ready to pour. The operation of assembling the mold requires about 3 hours.

The finished wheel must be perfect in diameter, location of center core, uniformity of pitch, correct blade location, and uniform blade thickness. In short, a perfect propeller wheel should result because the base plate is correctly machined; the positioning holes are located by templets from the center at the correct angle and distance; also, the pitch plane in both the nowel and the cope patterns is transferred from the machine-finished surfaces of the nowel pattern plate and the cope container to the fixed position from the machine-finished surfaces of each cope and each nowel. Therefore, when the machine-finished surfaces of the cope and nowel are bolted together, the two pitch planes of each return to contact, leaving an exact blade thickness, or pattern reproduction, in each blade mold. The top flange in the nowel is machined parallel to the bottom flange of the nowel and the nowels are all of even height, therefore when the nowels are bolted on the machine-finished assembly plate the pitch planes are parallel with regard to the assembly plate and also in relation to each other.

Fig. 1 shows a four-blade semisteel propeller wheel just out of the mold, with two blades cleaned from the adhering sand. After chipping off the fins at the blade edges, removing the sprue, and boring the hub, the wheel will be ready for shipment. The wheel as cast will be much more perfect and in much better balance than a machined wheel cast by the ordinary methods.

The same practice applies to the molding of individual blades, with the same economy of time, material, and accuracy of production. The process also is adaptable for molding machine use, which further lessens production cost. Wheels having blades of substantial size have been completely molded on a combination jolt and roll-over machine. While to date a roll-over device large enough to handle a 20-foot wheel has not been made, the construction of such a machine is in contemplation.

The mold is poured through gates located near the extremity of each blade, insuring uniformity of flow and metal distribution, as well as casting solidity and clean metal. The casting is left in the mold about 24 hours to avoid any danger of internal strains. The equipment is ready for the production of the next wheel as soon as the sand is shaken out of the cope and nowel. This sand, when cooled and wet down, can be used again on top of a new facing of sufficient depth to properly cover the pattern blocks.

For wheels built integral and for commercial use, the equipment is built in three standard sizes, 12, 16 and 20 feet in diameter. Each unit is designed for either three or four-blade wheels. For built-up wheels, the same standards are maintained.

The patterns are standardized in diameter to suit the equipment diameter capacity, and in pitch to standard practice. For example, the patterns for the 16-foot equipment would be of sufficient length to fit the container and consequently of diameter capacity from 12 to 16 feet. The pitches on the pattern blocks are standardized for, say, 6-inch pitch variation and the required pattern blocks for the 16-foot equipment would be 14 feet 0 inch., 14 feet 6 inches, 15 feet 0 inch, 15 feet 6 inches, 16 feet 0 inch, 16 feet 6 inches, 17 feet 0 inch, 17 feet 6 inches, and 18-foot pitch; or nine pitch blocks only are required to manufacture wheels of any diameter from 12 to 16-foot and with any combination of standardized pitch.

Assuming that wheel diameters increase by 3-inch variations, 108 combinations of wheel diameter and pitch may be made from nine standard pitch blocks by simply changing the length and width of the blade form on the pitch block. Thus, while the initial cost of one pattern block, including blade form, may exceed the cost of the ordinary blade and hub portion, the total pattern cost, by the use of this

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

ANALYSES OF TIN

(Concluded from Data Sheet No. 382)

COMPOSITION OF ENGLISH TIN

Common Tin

Impurity	A Per cent	B Per cent	C Per cent	D Per cent
Lead	0.339	0.374	0.380	0.387
Arsenic	0.038	0.078	0.060	0.077
Antimony	0.336	0.220	0.215	0.252
Copper	0.075	0.100	0.060	0.090
Cadmium	....	None	....	None
Bismuth	....	0.070	0.059	0.064
Iron	Trace	0.008	0.004	0.002
Zinc	Trace	....	....	0.006
Nickel & Cobalt	....	None	0.007	None
Manganese	....	None	....	None
Tungsten	....	....	None	None
Sulphur	Trace	....	0.002	0.006
Phosphorus	Trace	None	Trace	0.007
Tin by diff.	99.212	99.150	99.260	99.109
Total	100.000	100.000	100.047	100.000

English Refined Tin

Impurity	Analysed by A. H. Knight	Analysed by National Lead Co.
Lead	Trace	0.010
Arsenic	0.049	0.061
Antimony	0.032	0.039
Copper	0.015	0.014
Cadmium	....	None
Bismuth	0.002	None
Iron	Trace	0.002
Zinc	....	0.012
Nickel & Cobalt	None	None
Manganese	....	None
Tungsten	....	None
Sulphur	Trace	Trace
Phosphorus	None	Trace
Tin by diff.	99.920	99.861
	100.018	100.000

ANALYSES OF ANTIMONY

Impurity	Cookson's C A Per cent	Cookson's C D Per cent	Hallett's H A Per cent	Hallett's H D Per cent
Lead	0.041	0.102	0.669	0.718
Tin	0.035	Trace	0.175	0.012
Arsenic	Trace	0.092	Trace	0.210
Bismuth	....	None	....	None
Copper	0.040	0.046	0.038	0.046
Cadmium	.....	None	.....	None
Iron	0.010	0.004	0.014	0.007
Zinc	Trace	0.034	Trace	0.023
Nickel & Cobalt	....	0.028	.....	None
Sulphur	....	0.086	.....	0.128
Antimony (by diff.)	....	99.608	....	98.856
	.....	100.000	.....	100.000

Impurity	Japanese MC A	Japanese MC D	Chinese OO A	Chinese OO D
Lead	0.443	0.424	0.018	0.029
Tin	0.175	0.012	0.035	None
Arsenic	0.008	0.095	0.017	0.090
Bismuth	....	None	....	None
Copper	0.034	0.043	0.008	0.012
Cadmium	....	None	....	None
Iron	0.015	0.007	0.007	0.004
Zinc	Trace	0.023	Trace	0.027
Nickel & Cobalt	....	None	....	Trace
Sulphur	....	0.201	....	0.078
Antimony (by diff.)	....	99.195	....	99.760
		100.000		100.000

Reported by W. A. Cowan before the American Institute of Metals. Analysis *A* was made in the laboratories of the American Sheet & Tin Plate Co., and analysis *D* was made in the laboratories of the National Lead Co.

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

process, is ultimately greatly reduced.

Fig. 7 shows a wheel mounted on a balancing stand by means of a balanced turned arbor, in which are placed suitable keyways. Keys are inserted on each side of the hub.

Through such a test, not only can the static balance of the wheel be determined, but, by bringing a templet into contact with similar sections of each blade it will be seen that the wheel is uniform and correct in diameter, blade-thickness, and balance from an established center, which, through this procedure is accurately located for the subsequent boring that is necessary to fit the wheel to the end of the propeller shaft.

Many tests have been conducted to prove the accuracy and delicacy of this test. In one case three propellers cast from the same pattern, when tested after the hubs had been machined exactly alike, were found to weigh 10,430, 10,435, and 10,440 pounds. Four single blades cast from the same pattern weighed 3675, 3675, 3675, and 3670 pounds after the blade had been machined.

On an 18-foot 6-inch four-blade, 18-foot pitch, built-up wheel installed on the steamer MYSTIC. The weights of the four blades were 3475, 3475, 3475, and 3470 pounds. In operation the slip was reduced from 16 to 9 per cent and the time saved in the round trip voyage was approximately 10 per cent.

The steamer PATRICK HENRY, a standard U. S. shipping board vessel, of 12,500 deadweight tons, which was equipped with a Thacher process propeller, made on a light load trial trip a speed of 12 knots, which means a substantial gain over identical type ships having other makes of propellers. The weights of the four blades were 4345, 4345, 4348, and 4350 pounds. A 3-blade built-up manganese bronze propeller made by the Thacher process, one of a twin screw installation on the steamer HERMAN FRASCHI, developed no variation in balance when tested on balancing stand. In propellers used in the navy, manganese bronze, having an ultimate strength of 70,000 to 80,000 pounds per square inch, and an elongation of 20 to 35 per cent is specified. For commercial use many wheels have been made of semisteel. In the case of 30 such wheels, the lowest ultimate strength was 32,555 pounds per square inch, the highest 42,175 pounds per square inch; while the average was 36,658 pounds. The breaking of propeller blades has not been uncommon; in most cases this has been attributed to lack of perfect balance. It is not unusual for an 18-foot wheel to have a periphery speed of over 5500 feet per minute.

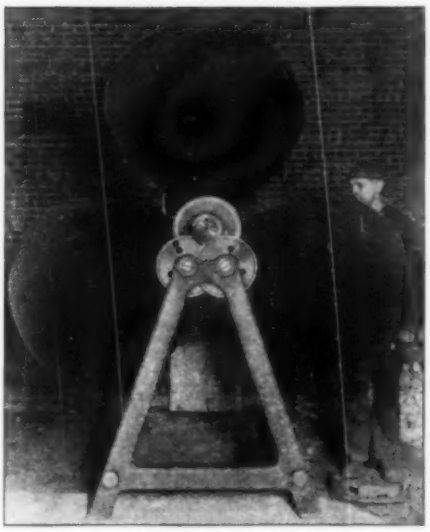


FIG. 7—WHEEL MOUNTED ON BALANCING STAND

By the use of this method, the following features can be guaranteed: The wheel will be a true circle; blade angle will be accurately established; pitch will be absolutely uniform; blade thickness will be correct to design; balance will be true in any position of wheel; more prompt delivery can be assured. From the foregoing there must result greater speed for same power, lower repair cost, fewer replacements, and more ship-service days.

New Plant Started in Chattanooga, Tenn.

The new plant of the Cole Engineering Co., Chattanooga, Tenn., has been placed in operation. The company manufactures nonferrous castings and also produces a white metal alloy and a special bearing mixture which is sold in ingot form. F. W. Cole, president and general manager, who has associated with him F. E. Klinck, formerly instructor in metallurgy at Cornell university, Ithaca, N. Y., also operates a plant at Chester, Pa. The Chattanooga establishment, which will be operated as the home plant has a capacity of 18 tons per day.

Formula for Ingot Molds

Question—We have installed an open-hearth steel furnace at our mill and would like to know the kind of iron to use for making ingot molds.

Answer—Usually iron of the following composition is employed for this purpose: Silicon, 1.75 to 2.00 per cent; sulphur, approximately 0.10 per cent; phosphorus, 0.10 to 0.15 per cent; manganese, 0.40 to 0.90 per cent. Some foundries feel that they can secure a mold with a longer life by reducing the silicon to increase the amount of combined carbon in the metal. With silicon as low as 0.75 per cent and sulphur up to 0.150 per cent the combined carbon will be near 1 per cent. Some small benefit also is obtained by keeping the phosphorus content near the lower limit which is given. An addition of 10 to 15 per cent steel scrap in the mixture helps to increase the life of the mold.

Protests Graphite Tariff at Newark Meeting

Jonathan Bartley, of the New York office of George F. Pettinos, Philadelphia importer and refiner of graphite, urged foundrymen at a meeting of the Newark Foundrymen's association recently, to write letters to the ways and means committee of the lower house of congress protesting against a proposed tariff on graphite.

A graphite tariff, as set forth in a bill now in the hands of the committee, would work a hardship on foundrymen, Bartley asserted. A duty of 6 cents a pound on all crystalline graphite that would pass through a ¼-inch mesh screen is proposed, and this additional cost probably would have to be absorbed by the foundrymen in the event the bill becomes a law. Virtually all of the graphite used in this country is imported, he asserted.

The foundrymen also discussed the training of apprentices. The association voted to extend co-operation for a new vocation school soon to be established here.

Members of the Association of Pattern Makers of Paterson, N. J., were the guests of the foundrymen, and subjects of co-operation between the patternmakers and foundrymen were discussed. The foundrymen directed their executive committee to appoint several of the members of the association to meet a committee of the patternmakers for further consideration of this problem. The following officers were elected for the ensuing year:

President, John De Hart, Isabel Porter Co., Newark; vice president, John L. Carter, Barlow Foundry, Inc., Newark; treasurer, James Williamson, Isabel Porter Co., and secretary, William H. Mantz, Atlas Foundry Co., Irvington, N. J. The following were elected on the executive committee: Arthur B. Jennings, Henry Worthington, Inc., Harrison; Robert Moore, Flockhart Foundry, Newark; William Goldsmith, C. A. Goldsmith Co., Newark, and David Sacks, Louis Sacks, Inc., Newark.

Reviews Properties of Gunmetal

Compositions and Physical Properties Called For in Different Specifications Are Compared and Views of a Number of Investigators on the Effects of Various Metals and Heat Treatments Are Cited

BY JOSEPH HORTON

(British Representative of THE FOUNDRY)

THE history and present-day manufacturing methods and metallurgical theories of gunmetal are discussed by R. T. Rolfe, of W. H. Allen, Son & Co., Bedford, Eng., in a paper read at a recent meeting of the Birmingham, Eng., branch of the Institute of Metals. Mr. Rolfe reminded his audience that the term gunmetal relates to the time when bronzes, containing generally from 8 to 11 per cent tin but sometimes less, were employed in the construction of cannon. Except for the fact that a little zinc is now added as a deoxidizer, gunmetal of the same composition is in common use today. The bronze age in Britain is generally considered to have begun about 1400 or 1200 B. C., when Phoenician intercourse, either direct or indirect, was responsible for the introduction of bronze. However, the use of tin, and probably of copper, dates back still earlier. This age probably lasted nine or ten centuries. The bronze age in Britain is apparently divided into three periods. The relics of the first period include flat or slightly flanged celts or hatchets, and the knife daggers frequently found in barrows which are associated with instruments and weapons of stone. The second period is represented by heavy dagger blades, flanged celts with ribs along the sides, and tanged spearheads or daggers. The relics of the third period include palstaves and socketed celts and many other forms of tools and weapons. The palstave is a winged celt having the side flange extended so as almost to form a socket for the handle. True socketed celts and spearheads were also found. Analyses of bronze articles from the later British bronze age showed much the same composition as modern admiralty gun metal. The most ancient bronzes, in fact, are composed essentially of copper and tin in the proportion of 9 to 1, the other metals, such as lead, iron and zinc, being present only in small quantities, probably as impurities.

Occasionally the proportion of lead is found to be too high to be considered accidental, while the tin falls to a very low percentage. It was suggested by Prof. Body Dawkins that the lead might have been used when the supply of tin had run short. Zinc was not known until just before the Christian era, when it was used in Roman coins. Bronze is thus more ancient than brass, and the brass mentioned in Exodus, XXXVIII 5, probably should be understood to mean gunmetal.

Turning to modern times the term gunmetal is generally used to denote the alloy of 88 per cent copper, 10 per cent tin and 2 per cent zinc. The admiralty specification gives the following composition: Tin, 10 to 12 per cent; zinc, 2 per cent maximum; lead, not to exceed 0.5 per cent; copper, the remainder. The physical properties required are ultimate tensile strength not less than 31,400 pounds per square inch; elongation, not less than 7.5 per cent in 2 inches, or in the case of gunmetal to resist high water pressure, not less than 3.5 per cent elongation. The air board specifications demand: Tin, 10 to 12 per cent; zinc, 2.5 per cent maximum; best new selected copper, not less than 86 per cent; lead, none. The physical properties required are: Yield point, 16,800 pounds per square inch; ultimate tensile strength, 31,400 pounds per square inch; elongation, 10 per cent in 2 inches.

Metastable Condition in Gunmetal

The air board specifications are thus a little more severe than those of the admiralty, although no difficulty is had in meeting it with metal of fairly good composition. No stipulation is made by either board as to purity of the tin.

Mr. Rolfe continues, one might ask why this particular composition had been decided on by the admiralty and what properties are found in similar alloys of slightly different composition. In the first place, the specifications require alloys containing not more than 10 or 12 per cent of tin because the ductility of the alloys rich in tin is low, while there is a considerable choice of alloys suitable for general casting purposes and of varying mechanical qualities with 10 to 12 per cent of tin. Some of the author's own results obtained from melts of the admiralty alloy and of two others show that with a progressive decrease in the tin and increase in the zinc there is a progressive slight decrease in the yield point and maximum stress figures, accompanied by an increase in ductility, due to the decrease in the proportion of the hard and brittle *delta constituent*. For certain castings such as bearings, discs, high-lift pumps, etc., the admiralty alloy is the most suitable. On the other hand, for general castings, where special hardness is not requisite it is obvious that the cheaper mixtures might often be substituted with great advantage.

Dealing with the cooling of the molten metal from fusion, Mr. Rolfe gives the constitutional diagram of the copper-tin alloys of industrial importance as reproduced in a paper by H. S. and J. S. G. Primrose from the work of Shepherd and Blough. From this, he says, it is clear that the admiralty alloy when in a state of equilibrium consists entirely of *alpha* and can contain none of the hard *delta* constituent found in alloys which have attained equilibrium, if they contain approximately 13 per cent of tin. On the other hand, a peak at 765 degrees Cent. indicates the formation of a certain quantity of *beta* constituent, which inverts at a lower temperature, a little below 500 degrees Cent., to a mixture of *alpha* plus *delta*. The long freezing range of over 200 degrees Cent. should also be noticed. The point of industrial importance is that the usual structure of gunmetal represents a metastable condition and only requires one of two things: either a sufficiently slow rate of cooling after casting, or a reannealing, to transform it to its stable state by the absorption of the *delta* constituent. It therefore follows that variation in the cooling conditions plays an enormous part in altering the structure and the mechanical qualities of the alloy. It is, for example, by no means uncommon to find in large castings that the structure is entirely *alpha* solid solution. Again, Arnott mentions a case where the structure of a small piece of gunmetal burned to a larger casting consisted, on cooling down, entirely of the *alpha* and *beta* solid solutions. This, of course, is rather unusual and was due to the suppression of the *beta* to *delta* change, caused by the rapid chilling brought about by the surrounding mass of comparatively cold metal.

A considerable amount of attention has been paid to the effect of castings temperature by different investigators, notably Karr and Rawdon, and Carpenter and

Elam. There is no doubt that the best results in casting this alloy were obtained by pouring within the limits of a so-called *safety range*, which is, as determined by Karr and Rawdon, between 1120 and 1270 degrees Cent. These figures were substantially confirmed by Carpenter and Elam. The author's suggestion is that in making large castings the top limit of 1270 degrees Cent. should not be exceeded, while small castings could safely be poured at a rather higher temperature, say, a little over 1300 degrees Cent. The lower limit of 1120 degrees Cent. might be rated slightly too high, as in his own experiments the author obtained no falling off till the metal had cooled down to about 1060 degrees Cent.

Mr. Rolfe quotes the figures of Karr and Rawdon in regard to the effect of remelting and points out that the evidence is conflicting. Perhaps the most complete experiments have been those made by C. P. Karr for the United States bureau of standards, the results of which are given in a paper read before the American Institute of Mining and Metallurgical Engineers in 1919. In these results, with chill-cast metal there is a marked falling off in strength with continued melting, the virgin metal giving the highest values. In the specimens cast in sand no marked effect due to remelting could be observed. This, Karr explains, might possibly be due to the maintenance of a low-pouring temperature, it being well known in foundry practice that government bronze (the American name for the 88:10:3 alloy) tends to deteriorate after two or three meltings. These results are not conclusive with regard to remelting, except in the pronounced deterioration of the chill-cast metal. The opinion expressed by Karr does not coincide with the results of another investigator. These results indicate that remelting increases both the strength and the ductility of sand castings. The analyses of the test bars after the various meetings show that the composition had not altered in the least, the improvement in properties being ascribed to the elimination of blowholes and the production of a fine-grained structure by remelting.

Remelting Decreases Strength

In the paper which Mr. Rolfe read last year on the effect of antimony and arsenic, he states that the effect of remelting on the antimonial series is slightly to decrease the strength and slightly to increase the ductility of the sand castings. With the chill castings the effect is apparently negligible. In the arsenical series the effect in the case of the sand castings varies with the proportion of arsenic, while there was a slight falling off in the strength and ductility of the chill castings. In a similar research on the effect of lead in gunmetal, the results of which are not yet published, the remelts of the sand castings show in each case an increase in the strength and ductility, while with the chill castings the effect is negligible. The results as a whole are so variable that further work is necessary before the question can be considered as definitely settled.

In many cases the supposed effect of any particular impurity, the author said, is conjectural and frequently there is no definite evidence on record to support the popularly accepted opinion. Much further research along this line which should include a study of the effect of all impurities which might occur in gunmetal is said to be necessary.

Aluminum oxidized in melting to alumina, which it is difficult to skim off, gives rise to films of this oxide between the crystal grains of the solidified alloy. It increases the amount of liquid, contraction, i. e. shrinkage, and, according to Johnson, is also responsible for a greater resistance on the part of the alloy to absorption of the *delta* constituent on annealing.

Antimony Hardens Alloy

The influence of antimony is dealt with by Mr. Rolfe in a paper he published in 1920 at the Barrow meeting of the Institute of Metals. Briefly, he says that antimony, added in ½ per cent steps up to 1½ per cent, hardens the alloy, causing a progressive falling off in the strength and ductility. Antimony also causes unsoundness in both sand and chill castings. Its effect on the microstructure of sand castings is to increase the proportion of intercrystalline eutectoid, but it has no noticeable effect on the microstructure of chill castings.

Arsenic is dealt with in the same paper of 1920. One of the most interesting effects of arsenic in sand castings is on the microstructures, the proportions of secondary *alpha* and of eutectoid being increased by it. A micrograph of a sand-cast gunmetal with 0.04 per cent arsenic showed 4¼ per cent of light areas; one with 0.42 per cent arsenic showed 8 per cent, and one with 1.01 per cent arsenic showed 18 per cent. The last specimen had 5.3 per cent of eutectoid alone, or 32 per cent of eutectoid in the light areas. This increase in secondary *alpha* plus eutectoid was not observable in chill castings, but a high proportion of arsenic caused a regular arrangement of the light areas, as was seen also in the sand-cast material.

Bismuth functions as it does in copper, giving rise to brittle intercrystalline films, and is therefore most objectionable in even the smallest proportions. It is not likely to occur in any appreciable quantity in gunmetal.

Iron is stated to give rise to hard spots which, according to Dewrance, are those of a tin-iron compound. This, of course, is not necessarily the only explanation, as in the case of contamination of gunmetal borings by iron borings the iron particles simply might not be melted. The theory of a tin-iron compound is supported by Primrose, who stated that iron makes its appearance in the *delta* constituent with as little as 0.11 to 0.15 per cent of iron. The effect of this constituent becomes noticeable at 0.3 per cent, and at 0.6 to 1.0 per cent the results are very harmful. Gulick has stated that iron increases the strength and decreases the ductility of gunmetal; while, according to Johnson, it increases the strength without any loss of ductility. It is therefore probable that iron is a prejudicial impurity. There is, however, need for much further work to determine its precise effects.

The effect of lead in improving the machinability of gunmetal is well known, the author says. An advantage was claimed by Dewrance for gunmetal containing ½ per cent of lead over lead-free gunmetal for use at temperatures up to 550 degrees Cent. This is disputed. With regard to the mechanical qualities of leaded gunmetal the progressive addition of lead, according to Primrose, causes a steady decrease in strength and ductility.

Mr. Rolfe states he has carried out work on the influence of lead, on the same lines as in the case of his antimony and arsenic investigation, and has obtained results quite different from those obtained by Primrose. It appeared that in sand castings up to a certain point, say 1½ per cent, lead slightly increases the strength and greatly increases the ductility of gunmetal, while it is only on exceeding this figure that any falling away in strength or ductility occurs. Again, it is quite possible to have 2 or 3 per cent of lead in gunmetal and yet have a margin over the minimum figures of the admiralty requirements for physical properties. Therefore, it is clear that the ill effects of lead have been exaggerated.

Lead Mechanically Contained

Mr. Rolfe says one point needs emphasizing, and that is that owing to the long cooling range of 200 degrees Cent., during which the lead is molten and practically the whole of the lead present is merely mechanically contained in the alloy, there is an increased tendency toward segregation of the *alpha-delta* constituent. Ramsay mentioned the extrusion from a heavy casting, containing an average pro-

portion of 0.5 per cent of lead, of a brittle white constituent containing 6.5 per cent of lead. The effect of lead in increasing the ductility of sand-cast 88:10:2 gunmetal is to some extent paralleled by its effect on 85:5:10 gunmetal. Taking bars cast in pairs and representing sand and chill castings of the normal alloy, and the same with 1 per cent and 2 per cent of lead addition, there is a slight falling off in strength with the increased lead content. A test of a normal sand cast alloy showed: Tensile strength, 37,600 pounds per square inch, elongation in 2 inches, 24.5 per cent, and of chill casting, tensile strength, 33,200 pounds per square inch and 8 per cent elongation. With 1 per cent lead the sand-cast alloy gave a tensile strength of 36,500 pounds per square inch and an elongation of 31.5 per cent; and the chill-casting showed a tensile strength of 34,300 pounds and an elongation of 14 per cent. The sand-cast alloy with 2 per cent lead gave a tensile strength of 35,600 pounds and an elongation of 33 per cent, and the chill casting 30,460 pounds tensile strength and 10 per cent elongation.

Manganese a Deoxidizer

Manganese, according to Gulick, acts as a deoxidizer, increasing the soundness and strength of the alloy while reducing the ductility slightly. Nickel is stated by Mr. Rolfe to give rise to unsoundness, owing to the liberation of gases during solidification. Arnott suggests that by using a rich nickel-copper alloy, thoroughly deoxidized by magnesium, this trouble would be avoided and the true effect of the nickel could then be ascertained.

Phosphorus as a deoxidizer might be added in small quantities with advantage. Arnott mentions a case where castings containing a maximum of 0.15 per cent of phosphorus, with an average of 0.08 per cent, gave unsatisfactory results in that the metal burnt into the sand excessively and a large shrinkage hole developed beneath each gate.

Silicon has been employed in place of phosphorus as a deoxidizer for gunmetal. Primrose states also that silicon could be absorbed by gunmetal which had been melted under glass. According to Guillet's work, the effect of silicon is not beneficial.

Dewrance tried the effect of a proportion of 0.25 per cent of silver in gunmetal, to resist a temperature of 700 degrees Cent., with results inferior to those of the ordinary alloy.

Sulphur, according to Arnott, frequently occurs in gunmetal castings to the extent of 0.08 to 0.12 per cent. A melt in which the proportion of this impurity had been increased to 0.39 per cent gave a brittle metal. The sulphur occurred as small black patches of copper sulphide. Increase of zinc, as already mentioned, causes a gain of ductility and a slight loss of strength.

The heat treatment of admiralty gunmetal was originally investigated in 1913 by H. S. and J. S. G. Primrose, who demonstrated that quenching between the temperatures of 500 and 700 degrees Cent. leads to a progressive falling away in strength and ductility, while at 200 degrees Cent. there is a slight improvement, giving about the same results as are obtained at 600 degrees Cent. On the other hand, annealing considerably increases the ductility and also the strength on account of the removal of the eutectoid from the microstructure, leaving only the crystals of the *alpha* solid solution. The annealing temperature found by those two experimenters to give the best result is 700 degrees Cent., both in dry sand and in chill castings. Long continued annealing produces a slight diminution in strength and ductility. It should be noted that Primrose found only a small improvement in strength on annealing dry-sand castings at the temperatures in question, while with chill castings the improvement was much more pronounced. In some experiments which Mr. Rolfe made in 1918, on the annealing of green-sand castings at different temperatures, he found that annealing at 700 degrees Cent. caused no improvement in the strength of the alloy. On the other hand, the ductility was considerably better than in the material as cast. Annealing was also performed at 250 and 350 degrees Cent. These tests were made to verify, if possible, the correctness of the claim made in a paper given by Longbottom and Campion at the meeting of the Newcastle Institution of Shipbuilders and Engineers in July, 1914. These investigators state that by annealing at 250 degrees Cent. as great an improvement was obtained as by annealing at 700 degrees Cent., an almost complete absorption of the *delta* constituent resulting. These investigators further state that at 250 degrees Cent. and upward the reformation of the cored structure takes place, the reappearance of the *alpha-delta* complex becoming evident, a change not accounted for by the form of the equilibrium diagrams as at present known. In a later note by H. S. Primrose results on dry-sand casting are quoted showing that no material improvement can be expected by annealing at 250 degrees Cent., while there is also no sensible absorption of the eutectoid. Mr. Rolfe found the same results in his own experiments.

This noteworthy discovery of the improvement capable of being brought about by annealing has not resulted in the process being brought into standard industrial use. Several reasons might be given for this, the chief one being that by proper control of materials a satisfactory margin over specifications can always be obtained without recourse to annealing. The possibility that treatment at a temperature of about 700 degrees Cent. may cause large castings to sag is an objection to annealing, although probably an unwarranted one. Finally, Mr. Rolfe says, it must be remembered that for many purposes annealing would cause a falling off rather than an improvement in properties and many users are unable to discern for what purposes annealing could profitably be employed and when it would render the material useless for the intended purpose. Annealing at 700 degrees Cent. on an alloy of normal composition results in a homogeneous solid solution with marked oxidation at the boundaries, and this, of course, is associated with unsatisfactory mechanical qualities.

Loss in Strength and Ductility

Investigations of Dewrance and of Longbottom and Campion show that when gunmetal is subjected to a temperature exceeding a point somewhere between 175 and 200 degrees Cent. there is a sudden falling away in strength and ductility. The maximum stress, about 29,000 pounds per square inch at the ordinary temperature, remained practically constant up to 200 degrees Cent. and then fell off, almost reaching zero at about 750 degrees Cent. The elongation rose to a maximum at about 150 degrees Cent, and then fell rapidly, reaching a nearly constant low value between 350 and 550 degrees Cent. The modulus of elasticity was constant up to about 200 degrees Cent. and then fell rapidly. It is thus evident that admiralty gunmetal is not suitable for employment at any temperatures much above the normal. Dewrance claims that the addition of 0.50 per cent of lead causes the initial tensile strength of the alloy to be maintained on heating up to a temperature of 280 degrees Cent., at which temperature a higher elongation was secured—much higher than that obtained from the same alloy at ordinary temperatures.

The effect of superheated steam cannot be judged by reference to tests made at the particular temperatures at which the gunmetal is to be used, because the action of superheated steam is not merely a question of temperature, but also one of chemical action. With many alloys, tested at the temperatures obtaining with superheated steam, say 200 to 300 degrees Cent., quite good results would be obtained; while if the same materials were actually subjected to the action of the steam for a period, they probably

would become quite rotten, giving extremely low results whether tested hot or cold. Quite apart from this, it is obvious that there are objections to the use of admiralty gunmetal, in which the strength can be seriously reduced merely by heating to a particular temperature, assuming this temperature to be at least higher than 200 degrees Cent., for any purpose involving contact with superheated steam. With a high degree of superheat, say 300 degrees Cent., the strength of gunmetal is reduced considerably, quite apart from any special action of the steam. Dewrance states that with the present use of superheated steam it is desirable that a bronze should be produced, to be used at 700 degrees Cent.

How and Why in Brass Founding

By Charles Vickers

Preventing Fine Cracks in Bronze Cams

We will greatly appreciate any suggestions leading to a solution of the difficulty we have experienced in casting bronze pump cams of the shape shown in the illustrations. The cam shown in Fig. 1, at A and B, weighs 49 to 50 pounds. It is made in green sand with the center hole cored. The crack shown in the drawing goes entirely through to the center core, and on machining frequently becomes wider toward center of section. We understand it is caused by the heavier parts pulling away and have tried every way to overcome it, but without good results. We now are gating the casting on one point and taking off a riser from an opposite point. We also ran with a riser off each point.

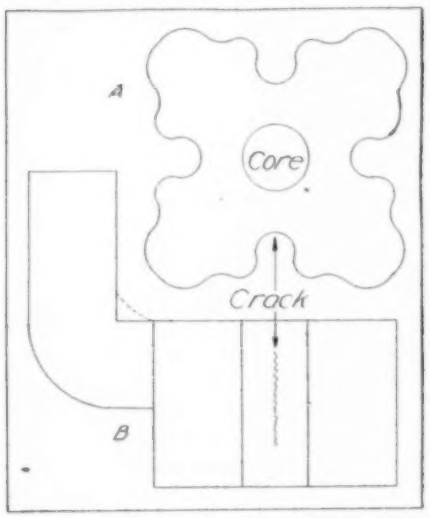


FIG. 1—CAM CRACKED AT CENTER AS SHOWN

The cracks do not appear on all cams cast. In fact we get as high as 50 or 60 cams perfect, and the next 5 or 6 will show cracks. Fig. 2, is a larger size we are just starting to cast. We are using ram-up cores in the slots and the crack, instead of appearing in the center of the groove, appears at the corners as shown in Fig. 2 at B. These castings are used in rotary pumps, and the greater number for pumping water. The cams are not subject to wear although interlapping. However, they must be sufficiently strong to withstand the pressure of pumping, and also be ductile so they will dent or give, instead of cracking in case that bolts, nuts, rocks, should be drawn into them with the water. We would like to learn if an aluminum mixture could be used. The castings are subject to considerable vibration.

As near as can be determined from a recital of the difficulty, the cracks are caused by shrinkage, and the temperature of the metal when poured into the mold, determines the presence or absence of cracks. Thus heavy rod brasses present a similar problem, the easy way to make them is to gate from the bottom and raise the metal into the cope. They have to be poured hot; otherwise, there will be cracks at the junction of the body and flanges, at the top. That some of the castings are good, proves they can be made in the manner now being used, provided the proper pouring temperature is known. To determine this, make two molds, pour one with hot metal, the other with cool metal. If this is the cause of the trouble, lay down rules as to the pouring temperature. Another way would be to pour the castings from the bottom, either cheeking off the mold, or carrying the gate down through dry sand cores. The riser, or risers would feed the casting better if they were placed as close as possible, about ½ inch away, and were connected to the casting entirely in the cope. In the case of soft metals, this method frequently is better than putting the riser on top of the casting. By standing the riser on the joint of the mold, but as near as possible to the castings, then cutting a footing out from the riser onto the cope of the casting, it will feed much better. Put a riser bushing over the riser in the cope, and carry it at least 4 inches higher than the sprue head. When the mold is filled put sand on the sprue, bed on a small weight, then fill up the riser head.

Light Weight Metal for Small Ornaments

We are making a white metal consisting of lead 87 per cent and antimony, 13 per cent, which we use for casting ornaments. We find this alloy is too heavy and would appreciate a formula for a lighter alloy.

If it is possible to cast the ornaments in aluminum, an alloy that is suitable would consist of aluminum

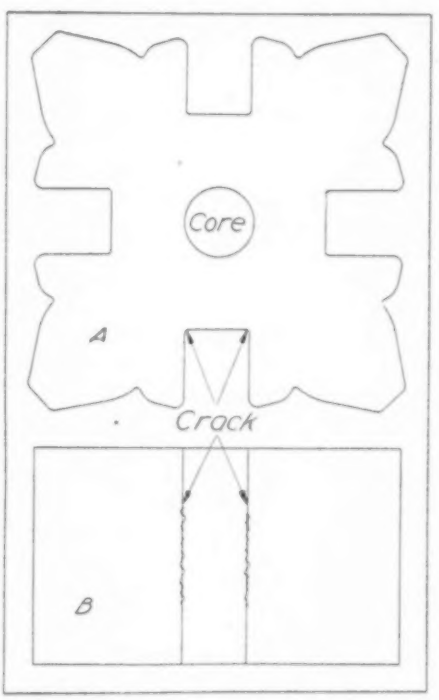


FIG. 2—LARGE SIZE CRACKED AT ANGLES

92 per cent, copper, 8 per cent. This alloy can be purchased ready made, or it can be easily made by first making a hardening alloy consisting of 50 per cent copper, 50 per cent aluminum, and melting 16 per cent of this hardener with 84 per cent of ingot aluminum.

The following alloy will be also lower in specific gravity tin, 87 per cent; antimony 10 per cent, and copper 3 per cent.

Figuring Percentages of Metals in Alloys

We desire to make an alloy consisting of 95¼ per cent of copper 8½ per cent of lead, and 5½ per cent of tin. How could we figure this in pounds? What does 100 per cent mean in pounds? Also what alloy of aluminum will withstand sulphuric acid? In general what kind of light alloy is best for acids, and is aluminum good for this purpose? We know lead will withstand acids, but it is too heavy for our purpose.

Per cent comes from two Latin words, per meaning by, and centum, meaning hundreds; therefore, per cent or per centum means by the hundreds. Thus 50 per cent of anything will be half; 25 per cent, a quarter; 75 per cent is three quarters. That being the case, we can write 8½ as 8.50; 95¾ as 95.75, etc. The formula given in the inquiry is not in percentages because it adds up to more than 100. It could be written as 95¾ pounds of copper, 8½ pounds of lead and 5½ pounds of tin. Then when it was weighed it would amount to 109¾ pounds. To get that into percentages means considerable figuring. It is necessary to add the amounts of copper, lead and tin together and then to divide the amount thus obtained into the amount of copper, lead and tin individually. Thus :

Copper	95¼ can be written	95.75
Lead	8½ can be written	8.50
Tin	5½ can be written	5.50
	109¾	109.75

It would be necessary to proceed as follows: Take the copper first, 95.75, which is the same as 95¾, only we get away from the fraction. It is not possible to divide 95.75 by 109.95, because the latter is the greater figure, but as it is necessary to multiply the 95.75 by 100, which is simply done by adding two ciphers, as follows:

```
10975 )957500( 87.24 copper
       87800
       -----
       79500
       76825
       -----
        2675O
        21950
        -----
         4800
```

The lead, 8.50, is divided by 10975; first it is made 85000, which gives 7.74 per cent lead, and the tin being now divided in the same way gives close to 5 per cent tin. This gives a total of 99.98, which is close enough, because it would be difficult to weigh if we carried the division beyond two figures in fractions of a pound.

Now, 87.24 per cent copper is practically 87¼ pounds, or per cent; 7.74 of lead is 7¾ pounds of lead, and 5 pounds of tin. Usually a formula like the above can be approximated closely, as it is not an important mixture. Thus if we add together the 8½ lead and the 5½ tin, making 14, and subtract this 14 from 100, it leaves 86 for the copper. Now, if we have lowered the copper we can lower the tin and lead, and especially the tin. Accordingly it would be natural to make the tin 5 per cent, then as the lead is the cheapest, to simply deduct ½ pound from the lead, leaving it 8. The pound we have just gained is now added to the copper and the formula becomes, Copper, 87 per cent, or pounds; lead, 8 per cent, and tin 5 per cent.

Aluminum withstands some acids, such as sulphuric and nitric, well, but it will not withstand hydrochloric acid or solutions of lye. One alloy of aluminum is as good as another for this purpose, and the alloy of 92 per cent or pounds of aluminum and 8 per cent of copper can be used.

Nickel Should Be Melted Quickly and Carefully

Please send us all the information you have in regard to the melting of nickel.

The melting point of nickel is 1450 degrees Cent., or 2732 degrees Fahr., that of copper is 1083 degrees Cent., or 1929 degrees Fahr. The first requisite to melting nickel is to have a furnace capable of reaching a temperature 1500 degrees Cent., and the quicker is can reach this temperature, the better it will be for the nickel. The longer the time of melting the more gas will be absorbed and the more difficult it will be to get solid casts. If ductile nickel is wanted, the melting must be done in vessels containing no carbon, as the content of this element must be controlled with the same certainty as in the case of steel. Too high carbon converts the nickel into a metal resembling cast iron. Pure nickel was placed in a clay crucible in an electric furnace, capable of attaining a temperature of 1400 degrees Cent., and was held there for several hours without effect as far as melting was concerned. The nickel was then removed from the clay to a carbon crucible, when it quickly liquified in the same furnace. It had absorbed carbon and had become like cast iron.

A flux of fluorspar and lime generally is used on nickel and a deoxidizer of magnesium is recommended. The molds for receiving the nickel must be faced with a refractory sand, the same as used for steel. If common brass molding sand is used it will fuse, liberate gas and cause gaseous castings.

Mixture for Brass Basin Cock Castings

We are sending you samples of stems for our basin cocks which were broken off while being machined. The following alloy is used: Copper, 85 per cent; zinc, 12 per cent, and lead, 3 per cent. This is melted in a crucible in an oil-fired furnace. The metal is charged as follows: First a few gates are put in the crucible with a flux, then the copper is put in, and when it is melted the zinc is added, then the lead, and about a pound of colored glass is thrown into the pot, which is a No. 70. About 80 pounds of gates of the same analysis is added to fill the pot. The break in the stem does not show a good metal, and we would like to learn why it breaks in this manner.

The stems crack while in the mold and the reason for this is that the alloy is hot short and a more expensive alloy which is free from this hot shortness would be much cheaper in the end. This alloy costs approximately $11.84 per 100 pounds. Figured in the same proportion the following alloy will cost $12.15 per hundred, or 31 cents per hundred more, and it will produce castings free from the defects noted. This alloy follows:

Metal	Weight in Pounds
Copper	83
Zinc	11
Lead	4
Tin	2

Alloying Nickel and Brass

We are called upon to make some castings containing nickel. We use scrap brass exclusively and would consider it a favor to be advised how to alloy the nickel with the scrap brass.

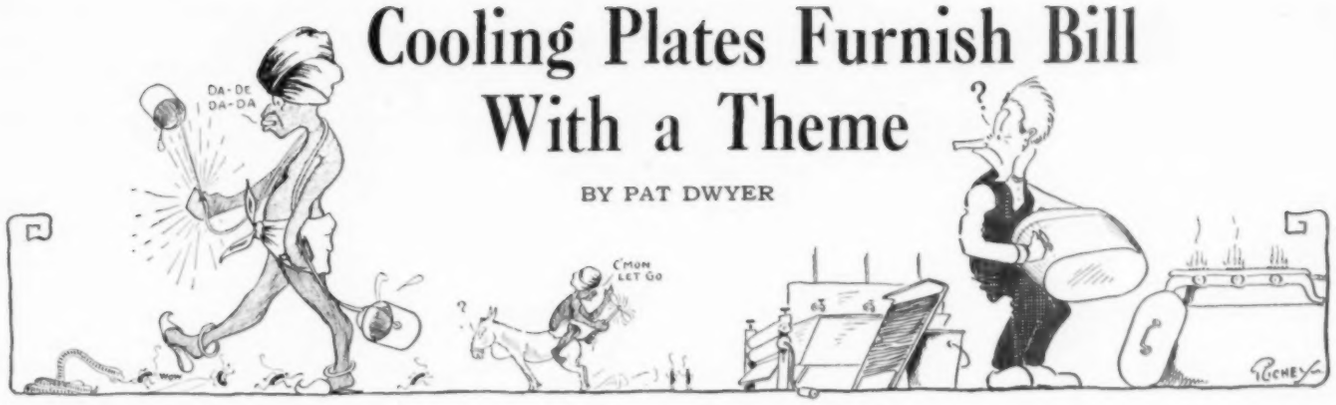
The best way to alloy nickel and scrap brass is to add the nickel as an alloy of copper and nickel. Two alloys can be obtained, one containing 25 per cent of nickel and the other 50 per cent of nickel.

Using scrap brass, it would be advisable to obtain the 25 per cent alloy. This would melt with the scrap, or dissolve with the same ease as copper. These alloys are found regularly on the market, and sources of supply will be found among the the advertisements in THE FOUNDRY.

However, such alloys are not difficult to prepare. The nickel and the copper in proper proportions are charged together into a crucible and the melt is covered with charcoal. The mixture is fused and then poured into small ingots. The prepared alloy is then melted with the scrap brass to give the desired nickel content.

Cooling Plates Furnish Bill With a Theme

BY PAT DWYER



ONE night recently I had occasion to verify a quotation from the works of Rudyard Kipling touching on the apparel or lack thereof worn by a valiant if humble soldier of the Queen who answered to the unromantic name of Gunga Din. I can remember the last lines:

"Though I've belted you and flayed you, By the livin' Gawd that made you, You're a better man than I am Gunga Din!"

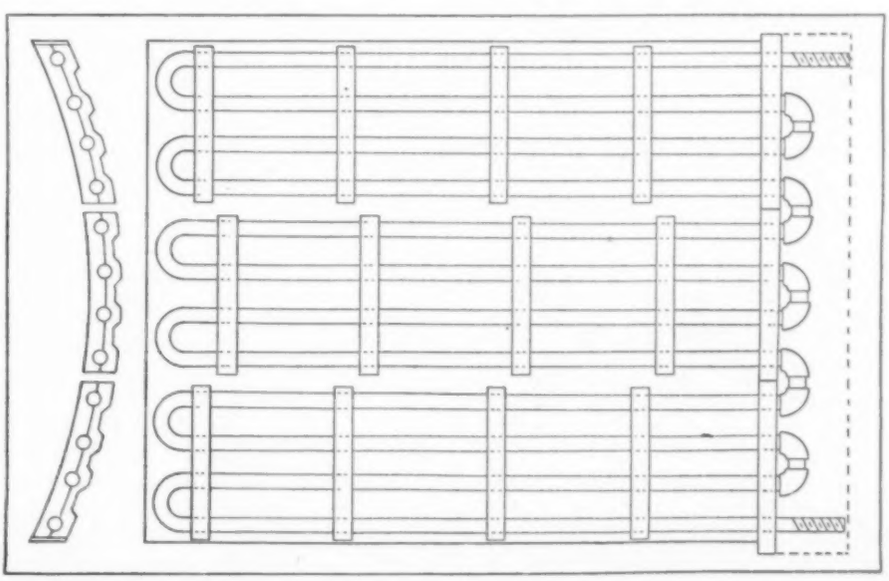
I never can remember whether it is: "'E 'ad nothing on before and rather less than 'arf of that behind;" or whether the description started at the back and came around to the front. Not that it makes any material difference, but I have read the poem so often and heard amateur elocutionists take liberties with it so frequently that I should be able to quote it off hand. Like many other things I should be able to do, nay, furthermore am expected to do I find when the time comes that the spirit may be willing but the memory is weak. "And so" as they say on the screen "I reached into one of the shelves of the old ancestral library and having selected a volume bound in blue and gold I was soon treading the flowery fields of fancy." Having satisfied myself on the subject of Mr. Din, his clothes, his habits and customs and his probable future destination where he would be sure to meet all his old army friends, I continued through the book and was deeply interested in the story of the *Mary Glouscester* when I heard Bill's big feet pounding on the veranda. I hastened to open the door for I knew if I did not he would playfully place his finger on the bell button and never let go until some person opened the door and if there is anything that makes me feel peevish it is to hear a door bell ring for any length of time.

He came in and picked up the book from where I had thrown it and proceeded to air his opinion of some of Mr. Kipling's standard works.

"You know" said Bill, "Old Brother Kipling jolly well hit it off when he said that the colonel's lady and Judy O'Grady were just alike under their skins. I don't pretend to as close and intimate a knowledge of the ladies as Mr. Kipling, but I have noted the peculiar resemblance of which he speaks and it is not confined to the feminine portion of the community by any means. If you have looked closely you probably have noticed that few men hate themselves. You also may have noted without unduly straining your notice that the average man thinks he is just a little bit better than his neighbor. He may not think he is a better Christian or a better citizen or anything like that, but he does think that he knows a little more about some particular subject than the next man.

"Consider our own business. Did you ever see any person get up a rig for making a job in the foundry that met with the approval of every one connected with it? No, you did not, neither did I and what is more I never expect to. The rig may be a good one and it may work satisfactorily, but Tom Dick and Harry look at it askance and deliver themselves collectively and individually to the effect that if they had had anything to do with it, the job would have been handled in a different manner. The same characteristics hold true in big jobs as well as in small ones.

"Practically half the repair work that comes into foundries connected with or catering to iron and steel producing plants is directly traceable to this peculiarity of human nature. Every time a new master mechanic or general superintendent gets on the job he decides that everything done by his predecessor was all wrong and so far as possible he scraps everything in sight and installs rigging of his own design or something he has lifted elsewhere and adapted so that he may call it his own. Of course the man on the job changes things around from time to time as his judgment may dictate and in proportion he may be in-



IT IS NECESSARY TO CAST A NEW SET OF CHAPLET BLOCKS FOR EACH CASTING THE END BLOCKS DO NOT REMAIN IN THE CASTING AND MAY BE USED OVER AGAIN

fluenced by what he sees, hears or reads of in other plants of a like character. However, the mainstay of the foundry (God bless him) is the new broom who as Poor Richard says in his famous almanack 'Always sweeps clean.'

"I have known foundrymen, excellent and estimable gentlemen in every way, men who would no more think of short changing their customers more than the usual 10 per cent than they would of putting a counterfit nickel in the plate on Sunday. I have known these men in dull periods to wish fervently that something would happen to the men responsible for ordering castings. I don't go so far as to say that they would wish these men to meet a sudden and violent death, but if they should resign or get fired or calmly decide to shuffle off this mortal coil in a quiet and peaceful manner the foundryman would feel like giving three of those rousing cheers.

"In fact he would be one of the first to put his name on a subscription list having for its object the purchase of a slight token of respect and esteem for the departing dignitary, providing the latter was leaving for fresh fields to conquer; or a nice floral wreath if he was going on a personally conducted tour with the undertaker.

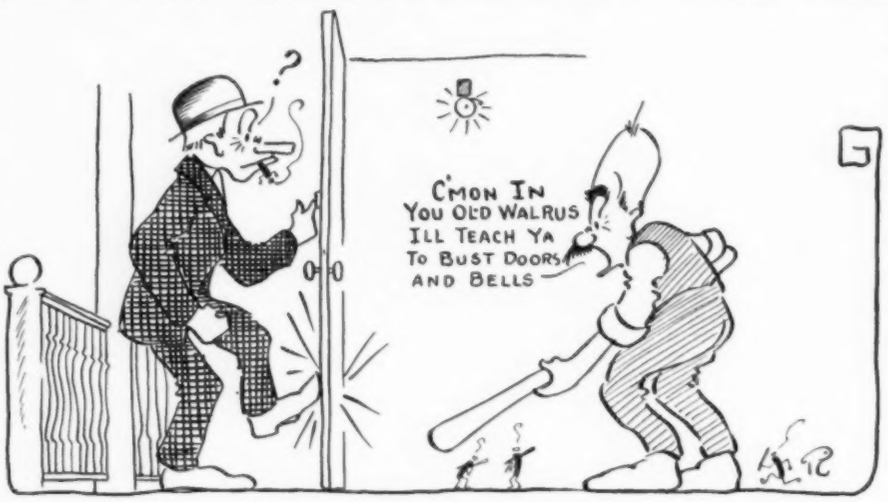
"For one reason or another, including the foregoing, the fixtures and equipment around a blast furnace plant are changed more frequently than those in any other part of the industrial field. Every blast furnace superintendent has his own pet ideas that involve practically every casting from the charging hopper to the iron notch and the clay gun. If he does not make any changes while the furnace is in blast, he is sure to indicate numerous changes and alterations when it is blown out for a general overhauling. For a month before the furnace goes down he sits in his office with a pile of blue prints in front of him and the unholy joy with which he runs his red pencil over those drawings is one of the reasons why the boss patternmaker has gray hair and very little of that, and it also accounts for his little short finger nails bitten down to the quick.

"The water cooling system in particular is one with which no superintendent ever has been satisfied. No thought apparently ever is given to the difficulty of producing some of these castings. In fact, the more weird and complicated the castings are, the nearer they come to meeting the blast furnace man's idea of perfection. One of these curved castings made in sets of 12 sections and varying in width from 2 to 8 feet, depending on the diameter of the furnace is a fair example of what I mean.

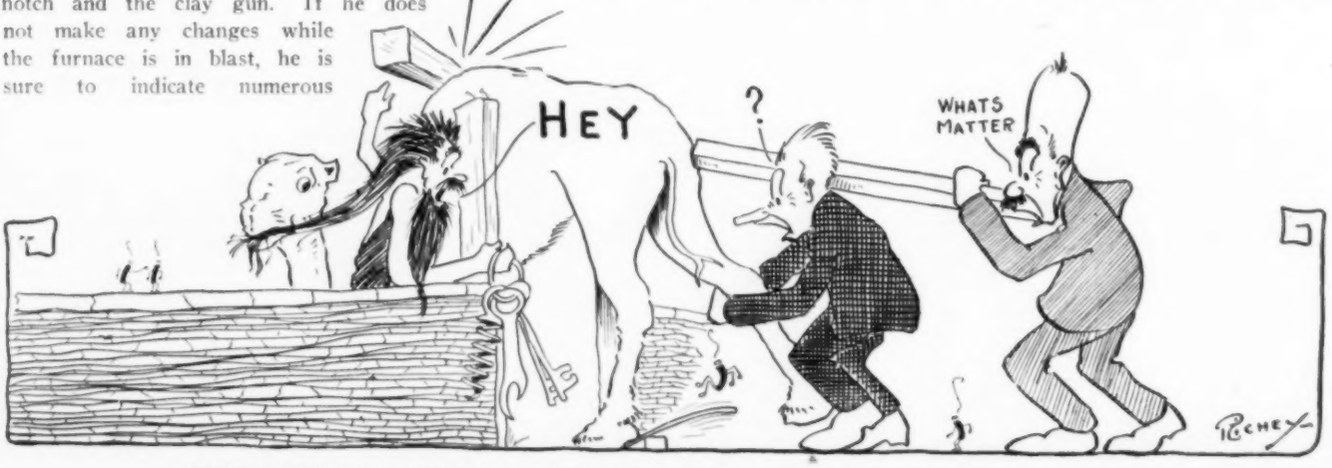
"These castings generally are about 3 inches thick and are provided with a number of coils of heavy pipe, cast in. Any foundryman who has had experience in making castings of this character knows how difficult it is to prevent the pipes from buckling and cutting through to the face of the mold. Owing to the curved shape of the casting long stem chaplets are extremely difficult to set and still more difficult to anchor in position. The pipes develop a tendency to wiggle side ways as well as up and down and even though the chaplets are properly spaced and wedged down securely their purpose is defeated by the eccentric behavior of the pipe coils when immersed in molten iron.

"I worked in a shop at one time where this problem was solved in an ingenious manner and I often have adopted the same idea since when making jobs of a similar or related character. Some of the details, such as the number of pipes in a coil and the manner in which they are joined together may vary in individual cases. The accompanying illustration shows a typical mold with the pipe coils and anchors in position in the casting. If the castings were made on a production basis, special flasks with the ends cut to conform to the shape of the curved pattern could be made, but as I said before the details change so frequently that ordinary iron flasks are employed.

"The drag for this mold may be rolled over but where a whole set of castings is ordered or even two or three single castings a considerable saving in time may be effected by bedding the pattern in the drag. The bottom plate must be clamped on, the cinder bed adjusted and the drag filled with sand for the first casting no matter whether the flask is rolled over or not. However, for each succeeding casting the same procedure must be gone



TO WELCOME FRIENDS AND SPEED THE PARTING GUEST



THAT CAMEL THAT TRIED TO SNEAK INTO HEAVEN WITHOUT REMOVING HIS HUMP

through if the rollover method is employed, while if the pattern is bedded in the drag the flask, bottom plate and cinder bed remain permanently in one place and are not disturbed until the entire number of castings have been made. Another difficulty suggests itself. A large flask is apt to acquire a twist when it is rolled over, unless a suitable foundation is prepared upon which it can rest. This twist is transferred to the pattern and the result will be a distorted casting that will not line up with its fellows when the entire ring later is assembled.

"Assuming that the pattern is to be bedded in the drag the first step is to set the bottom plate on a pair of rails about 12 feet long, laid parallel and level and about 4 feet apart. These serve the double purpose of supporting and reinforcing the bottom plate and also provide a free egress for the gas and steam driven through the bottom plate when the mold is filled with iron.

"The drag is then set on the bottom plate and adjusted by driving a number of wedges between the lower flange and the bottom plate until the upper flanges are level and parallel. The bottom plate then is bolted or clamped to the lower flange after which a layer of coke or cinders from 4 to 8 inches thick is spread all over the bottom plate. On account of the curved shape of the pattern, the cinder bed is made thin in the center and deep as it approaches the two sides. In this manner the average thickness of sand between the pattern and the cinder bed remains the same.

"Black sand is shoveled in, tramped and butted off approximately to the shape of the lower surface of the pattern. The face of the mold then is vented all over after which a layer of facing sand is shoveled in and tramped lightly and then a long strike with a deep belly and having the two ends resting on the flanges of the flask is employed to scrape the superfluous sand from end to end of the mold. The resulting surface serves as a bed on which to set the pattern.

Duplicate Castings

"In cases where a considerable number of duplicate castings are required it is customary to provide special stools resting on the bottom plate for supporting the pipe chaplets, but for single jobs the outline of the pipe coils can be traced on the face of the mold and then a number of pieces of iron plates can be hammered down at the points where the different chaplets will rest.

"The pattern usually is of plain but rigid construction and is provided at one end with an extension corresponding to the usual core print. This is shown by the dotted line at the right end of the illustration. Its purpose will be touched upon when describing how the chaplets are set. After the pattern has been set, the drag is rammed to the top and a parting made. The cope is provided with deep hanging bars to carry the *lift*. Two gate pins are set about a foot apart near the center of the joint at the end of the left end of the mold as shown in the illustration The cope is rammed and lifted off and if the crane and oven capacity are equal to it the cope is rolled over, finished and run into the oven to dry. If this method is not convenient, the cope may be set upon four stands and the under surface skin dried. Drying the cope is done for two reasons. The first is to prevent it from dropping or *drawing down* and the second is to secure a hard firm surface where it comes into contact with the chaplets.

Setting the Chaplets

"After the pattern has been drawn out of the sand and the mold has been given a coating of plumbago the lower halves of the chaplet blocks are set on the plates previously placed in the face of the drag mold for their reception. A sectional view of the chaplet block is shown at the extreme left of the illustration. It is made in three sections for this particular plate and each section comprises a top and a bottom half. The block at the right end also is made in three sections, but on this end the sections are designed to touch each other and form one continuous block. It will be noted that the chaplet block at this end of the mold serves as a stop off and forms the outside end face of the casting. The notches on the drag half of the chaplet blocks designed to promote the flow of iron and add strength to the finished casting are omitted from the right end blocks.

"After the lower halves of all the chaplets have been placed, the pipe coils are set into the mold. Then the top halves of the chaplet blocks are set on after which the open space outside the right hand chaplet block is filled with sand and rammed so that if any iron leaks through it will not enter the open ends of the pipe. The cope then is set on, the runner made up and the casting poured, and I want to tell you in conclusion" said Bill, "that when a set of pipes is gripped like that, fore and aft, up and down and cross ways they stand about as much chance of shifting out of position as that well known and famous camel had of getting into heaven. You know, the one who tried to sneak through the eye of the needle without observing the formality of removing his hump!"

Iron Molds Unsuitable

By H. E. Diller

Question—Can steel castings be made successfully in iron molds? We make castings with thin sections and these castings must stand internal pressure air tests under water, but many of them leak. We think the trouble could be overcome if the castings were made in cast iron molds.

Answer—So far as we know, no one has ever tried to make light steel castings in iron molds, although gray iron is cast in iron molds in some foundries. Steel cast into an iron mold would chill too quickly to allow it to follow the contour of the mold if in a thin section. You will undoubtedly get better results by using a sand mold. One foundry making light steel castings has obtained excellent results by using a jar-ram machine for making the molds. With this machine, the density of the sand can be predetermined and always brought to the point to give a good venting condition in the mold.

Buy Eastern Factory

Skinner Bros. Mfg. Co., Inc., St. Louis, manufacturers of heaters, air drying and blow pipe apparatus, recently has acquired a factory covering 3½ acres of ground, located at Elizabeth, N. J. This factory will be used to produce equipment for shipment east of Pittsburgh. The general offices of the company are located in St. Louis. Fred A. C. Skinner is president and Merrell G. Skinner is vice president and secretary.

Moves Chicago Office

The Mesta Machine Co., Pittsburgh removed its offices, on May 1, from the temporary location in the Railway Exchange building to permanent quarters in the McCormick building, Michigan Blvd., Chicago.

Open Branch in Detroit

Briggs & Turivas, dealers in iron and steel scrap and used materials, with offices at Chicago and numerous other important points, have opened a branch office at 1802 Real Estate Exchange building, Detroit, in charge of Earle A. Mann. Mr. Mann formerly was connected with Willys-Overland, Inc., and the General Motors Corp.

The name of the Glass-Arthur Iron & Brass Foundry has been changed to the Piedmont Iron Works, Gastonia, N. C. K. M. Glass is president and general manager.

Traces Development of Refractories

Industry Has Kept Step With Manufacture and Fabrication of Iron and Steel Since Introduction of the Open Hearth—Synthetic Refractories a War Product Crowd Foreign Magnesite

BY C. B. STOWE

THE iron and steel industry now is using for refractory work in the order of their importance the following brick: Fire clay, silica, magnesite and chrome.

The first refractory brick made in this country were of fire clay, which is a combination of silica and alumina, with a minimum fluxing content. Large beds of fire clay were first found in New Jersey, and the honor of being the first producer of fire brick in the United States belongs to that state. The first fire clay brick are said to have been made in 1812, although just where the plant was located is not known. It is definitely known, however, that the Salamander works, of Woodbridge, N. J., were in operation in 1825. The works are no longer standing. This was followed by the erection of a factory by John Watson in 1833, which remained in operation for a number of years. The plant was on the Raritan river on the present site of the Raritan Copper Works.

It is also stated that fire brick were made in Florida and shipped to New Orleans in 1827, but statements referring to the location of the plant and the shipments are not confirmed. Fire clay stove linings were made in Connecticut in 1837. These brick probably were made from New Jersey clay transported to Connecticut.

In 1830 three seams of coal and a thick bed of fire clay were discovered on Queens run, Lick run and Tangascootac creek in Clinton county, Pennsylvania. This material was at the head waters of the west branch of the Susquehanna river, the farthest point west that water transportation could be had. William P. Farrand, of Philadelphia, acted as agent for Boston capitalists and started an operation at Farrandsville, Pa. At that time the location could only be reached by a horse path at low water, and the coal and clay deposits were opened up and an ironworks started, having a capacity of 10 tons of nails per day.

About $700,000 was expended by the company, and a steamboat was constructed for towing the coal and other material down the river. This operation was later abandoned, for the reason that the iron ore was too low in iron content, but the fire clay was developed later. The site of the plant is now that of the Farrandsville plant of the Harbison-Walker Refractories Co. The first fire brick in Pennsylvania were made on this property, and the first bituminous coal developed for commercial use in Pennsylvania with transportation to the east was mined in this section.

The first permanent development in Clinton county, Pa., for fire brick was begun at Queens run in 1836, and operations have been continued up to the the present date by the Queens Run Fire Brick Co. Clinton county clays, both plastic and flint have continued to have a high reputation, and the clays are now utilized by some of the leading fire brick plants in Pennsylvania. At Lock Haven, Mill Hall and Beech Creek, Pa., the coal veins were neglected, although one of the veins of coal was of the same grade as the Blossburg vein, which is the highest grade in Pennsylvania. The veins were small and transportation poor. The Lock Haven Fire Brick Co. which has used the Tangascootac clay for years, is now opening up the coal mines on the Tangascootac creek which were abandoned in 1840, and some of the best coal and clay deposits in the state now are being developed in that section.

In 1837 fire clay was discovered at Mt. Savage, Md., and two years later the Union Mining Co. began operations which have continued up to the present. About this time the Lower Kittanning plastic clays and the Clarion county flint clays of Pennsylvania also were mined by S. Barnes & Co. of Rochester, Pa. In 1842 James Glover discovered fire clay at Bolivar, Pa., and started a small fire brick plant there. He developed the business at Bolivar and took his brick to Pittsburgh by boat. Kier Bros., of Salina, Pa., began operations in 1845, and the operations are now conducted by the Kier Fire Brick Co.

The development of the fire clay brick industry moved westward and in 1846 the manufacture of fire brick was begun in St. Louis, with a small factory located on Gravois road. This factory is no longer in operation, the oldest of the present plants being that of the Evans & Howard Fire Brick Co. and the Laclede Fire Brick Co., established in 1855, followed in 1857 by the Christy Fire Clay Co., and the Parker Russell Mining & Mfg. Co., in 1866.

Fire clay was discovered along the Ohio river in connection with coal in 1840, and a small plant was started at Wellsville, O., in 1842. About the same time the Rainbow plant was established at New Cumberland, W. Va., by James S. Porter. A small plant at Hammondsville, O., was started about 1846. A larger plant was built at Empire, O., by Francy & Stewart in 1869. Despite several fires this plant is still operated, by the Minor Fire Brick Co.

About 1850, both flint and plastic clay was found with coal in the hills around Canal Dover, O. The clay was similar to the Mt. Savage clays, and a small plant was built in 1857 by the Dover Fire Brick Co. The clay was hauled by team from a radius of 10 miles to this plant. The brick were used largely for puddling furnaces and charcoal blast furnaces in Ohio, Michigan and Indiana. Later, it was found that teaming was too expensive for competition, and as the best bodies of clay were located near Strasburg, O., the Dover Fire Brick Co. moved its plant to the clay, and Strasburg is now the central location of five large modern plants which have been developed by reason of

Industry 109 Years Old

ONE hundred and nine years of development in the making of refractories used in the manufacture of iron and steel is sketched in the accompanying article by C. B. Stowe, president Stowe-Fuller Co., Cleveland. From the time fire clay brick were first made from the clays found in New Jersey, in 1812, to the manufacture of synthetic material to substitute for Austrian magnesite, contributing largely to the making of steel during the war, the progress has been in steady accompaniment with the needs of the iron and steel manufacturers. The article was read before the annual meeting of the Refractories Manufacturers association in New York, March 17-18. Mr. Stowe was chosen to prepare the historical sketch, as he was the oldest active member in the business, having been identified with the development of the industry for 40 years.

the quality of the clay and the cheapness with which it can be mined in connection with coal, by steam shovels.

Flint clay and plastic clay also was found in southern Ohio in the Portsmouth and Oak Hill districts, and between 1880 and 1888 plants were developed at Portsmouth, Oak Hill and South Webster. A very satisfactory blast furnace brick was made for many years with a combination of clays.

The fire clays of Lewis county, Ky., were mined as early as 1871 and used for making fire brick at Cincinnati. The plant of the Kentucky Fire Brick Co., at East Portsmouth, was built in 1870. About 1880 more Kentucky clays were found and fire brick were made at Ashland, Ky., by the Ashland Fire Brick Co., in 1886. In 1895 the Olive Hill Fire Brick Co. began to mine the clays in the Olive Hill, Ky., district, and today there are five modern plants in that district, aside from the original Ashland plant which first used the Kentucky clays.

A large number of new plants were started during this period in Pennsylvania, as choice clays were developed in Clearfield and Clarion counties. They included the Woodland works, in 1871; the Retort and Manorville plants in 1872; Phillipsburg, Pa., plant in 1893; the Clearfield, Pa. plants, in 1894 and the Beech Creek plant in 1900.

Development in Illinois

Plastic fire clay of very good quality was found under the coal near Ottawa, Ill., in La Salle county, and a plant was built there in 1879. This operation was extended several times and is the present site of the Chicago Retort & Fire Brick Co.

About the same time very good fire clays were located in central Missouri, and the manufacture of brick was commenced at Fulton and Mexico, Mo. This section has been developed in the past 10 years to a larger extent than any other district for the manufacture of fire clay brick, and several plants of large capacity are operating.

The Dakota clays were discovered in Colorado in 1866, first around Golden, Colo. They were developed at Canon City in 1900. Since that the clays have been found in Utah, Montana and South Dakota.

The fire clay brick business developed with the remarkable increase in the iron business until about 1885, when the open-hearth furnace began to replace the bessemer process. This required a new refractory. Silica brick, which had been used only in small quantities, were imported from England, except for a limited amount produced in this country. The first experiments are believed to have been made by J. Park Alexander, Akron, O., who started the manufacture of silica brick in Akron about 1867. He conceived the idea of making silica brick after seeing the Dinas and Abernath imported brick. He made them from a conglomerate quartz pebble found near Akron.

The manufacture of silica brick proceeded in a small way until Isaac Reese commenced making them at Manorville, Pa., from what is known as Juniata ganister. The making of silica brick, however, did not become important until the open-hearth furnace was developed. Then the Harbison-Walker Refractories Co., at Pittsburgh, and Haws & Sons at Johnstown began the manufacture of the brick from Juniata ganister, bringing the stone to their plants. It then developed that it was necessary to make silica brick at the source of the material to keep down the cost, and large plants were developed at Mount Union, Alexandria, Claysburg and Hawstone, Pa., to supply brick to the eastern market.

As great developments were made in Chicago and the West in open-hearth steel plants, and very good rock had previously been shipped from Baraboo, Wis., to the plants at South Chicago, Ill., for bessemer linings, it is thought that L. D. Doty, former purchasing agent of the Illinois Steel Co., should be given credit for bringing to the Chicago district the silica brick plants now located at East Chicago and Joliet, Ill. Baraboo ganister has been brought down from Wisconsin, and for some years made into silica brick to supply the requirements in that district. First-class silica brick also are made at Canon City, Colo., Salt Lake City, Utah, and in the last few years silica brick has been made in eastern Pennsylvania near Downingtown, from the ganister rock in that section. Today the manufacture of silica brick stands second only to fire clay brick in quantity.

Magnesite Brick in Demand

When the basic open-hearth furnace was established, it was necessary to find a basic material, and magnesia brick and magnesia bottom material was first brought to this country from abroad. The first magnesite brick that ever came to America, it is thought were brought here about 1882. The Canadian Copper Co. put up an experimental plant at Brooklyn, O. The writer was asked to supply some magnesite brick, and had never heard the name mentioned at that time in refractory work. He wrote to some of the leading engineers in the East and could get no information, but the French engineer who came to build the plant had used some in France. A car load was imported for the plant. The brick were made in France of Grecian material, and the Canadian Copper Co., should be given the credit for using the first magnesite brick ever brought to this country.

For a number of years magnesite brick were imported from England, and afterwards from Austria and Hungary. The first magnesite brick industry in this country was established by the Fayette Mfg. Co., at Layton, Pa. The plant was afterwards sold to the Harbison-Walker Refractories Co., which later started to manufacture magnesite brick at Pittsburgh, and then at Chester, Pa., so that the imported material could be landed at the plant. In 1905 the manufacture of magnesite brick was begun at Alexandria, Pa., by the Federal Refractories Co., and about the same time by the Haws company, at Johnstown, Pa., and later by the American Refractories Co. at Joliet, Ill. The latter company found it necessary to develop a plant at Baltimore, Md., to be on seaboard for the foreign material. During the war period magnesite brick were made at Sandy Ridge, Pa., and near St. Louis.

Contributed to War Enterprise

At the outbreak of the war the only refractory material that America was not fully prepared to furnish in any quantity was magnesite material for the manufacture of basic steel. The government and steel manufacturers were very doubtful whether the refractory manufacturers could furnish sufficient American material to keep up the output of steel, which was then at the highest rate in the history of the steel business. Prior to the war, 99 per cent of all the magnesite brick made in this country were made either from Austrian or Hungarian calcined magnesite. During the war this material could not be obtained, and a synthetic grain material for the manufacture of magnesite brick was developed in this country, which gave equal or better results than the Austrian material. It could be made more regular than the natural product.

It is necessary to calcine magnesite material before shipment, for the reason that the crude material contains 52 per cent CO_2 gas, which is thrown off in the burning of the material before being made into brick. It is impractical to ship the crude material.

The crude material found in the Tyrol and Carpathian mountains in Austria and Hungary, contains the requisite amount of iron in the natural state for the making of a good bottom material or brick without any admixture, but it carries a percentage of lime in the free state. This makes it impossible to hold

the iron if in any great quantity. By the synthetic process, the material made in this country, either from American or imported crude material, it is possible to add the iron, which is the fluxing element, in any desired amount. Large plants for the manufacture of grain magnesite have been located since the war at Chewelah, Wash., and Magnesite, Que. The results obtained in many cases have been fully as satisfactory as those with the Austrian material. A large amount of Canadian grain magnesite has been shipped abroad to some of the steel plants in other countries.

This country would have been handicapped during the war period had we been unable to get magnesite on this side, but American ingenuity took the crude materials we had and duplicated the Austrian materials in a scientific way, so that the output of steel was increased.

Chrome brick came into use in a small way as a "neutral" brick, between silica and magnesia, and also for copper smelting. The manufacture of chrome brick has not been very extensive. They have been made at Pittsburgh, Chester, Alexandria and Sandy Ridge, Pa., Baltimore, Md., and Joliet, Ill. The use of chrome brick increased during the war as they could be used in place of magnesite brick, but when magnesite brick was supplied at a fair price, there was not much demand for chrome brick. One of the leading refractory authorities in England has informed the writer that the same was true in England. In that country chrome cement is being used between silica and magnesia brick in place of chrome brick.

Molding Sand Output an Increase Over 1919

Production of molding sand in the United States was increased in 1920 over the output of 1919 according to the report of the United States geological survey, although many producers reported their output had been curtailed 10 to 30 per cent on account of the inability to get railroad cars. The output increased more than 1,000,000 tons from 3,774,612 short tons in 1919 to 4,890,000 tons in 1920, and the value showed even a greater increase being raised from $4,153,990 in 1919 to $7,473,000 in 1920. Thus the production in 1920 was practically the same as that in 1918 which amounted to 4,910,178 short tons, but the value of the 1918 output was only $5,121,865.

Pittsburgh Foundrymen Elect Officers

Views of the designing engineer were given by H. M. Lane, of the H. M. Lane Co., Detroit, in an informal address at the May meeting of the Pittsburgh foundrymen's association. Mr. Lane said that the efficient foundry should be designed to minimize human motion and eliminate the necessity for back crossing of the work. In connection with the latter he said that this does not necessarily involve continuous operations, that his preference was the unit principle rather than any continuous belt arrangement. He said that from the entry of raw materials until the exit for shipment of the finished product, all processes should be straight forward with as few motions per ton in as few man hours as possible. Typical foundry designs and installations were illustrated by stereoptican slides and the right and wrong features of each were pointed out.

The following officers were unanimously elected to serve for the ensuing year: President, F. H. Clay, foundry superintendent, Allegheny Steel Co., Brackenridge, Pa.; and vice president, Samuel B. Cuthbert, superintendent of foundry, Edgar Thomson works, Carnegie Steel Co., Braddock, Pa. Secretary, Bayard Phillips of Phillips & McLaren Co., and treasurer, William J. Brandt, both of Pittsburgh, were re-elected.

Benjamin D. Fuller Niagara Falls, N. Y., ex-president of the organization was unanimously elected an honorary member of the organization. Arrangements for the annual outing to be held June 20 have been left in the hands of the executive committee and announcement will be made later regarding the place where this picnic will be held.

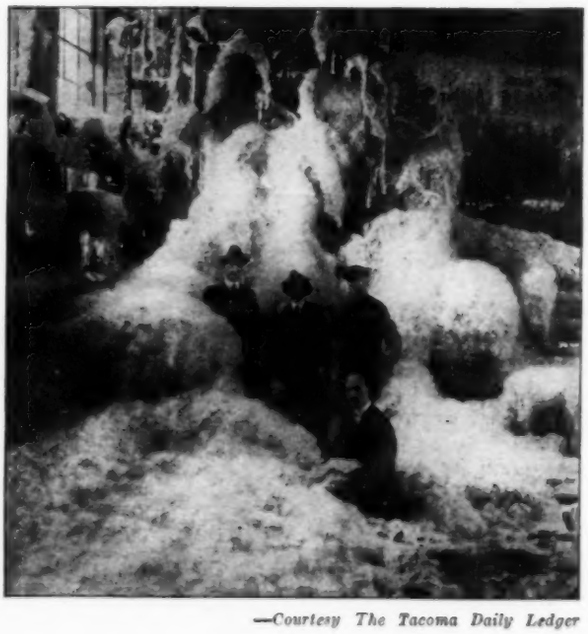
The Combustion Engineering Corp. has moved into its new building, 43-47 Broad street, New York.

Manufacture Slag Wool on the Pacific Coast

The problem of utilizing the slag incident to the manufacture of ferromanganese has been solved by the Bilrowe Alloys Company. Tacoma, Wash., by the installation of an electric furnace and other equipment whereby the formerly useless by-product is converted into a valuable commodity known as slag wool and greatly in demand at the present time for insulating and packing purposes.

The company which has been manufacturing ferromanganese for some time has hundreds of tons of slag and it was only discovered recently that this slag formerly considered to be useless could be converted into slag wool at a profit. A special electric furnace for melting the slag and machinery for blowing the wool were constructed. The result of part

A jet of steam at high pressure blows the molten material through a huge pipe in the shape of a shower of sparks. The cooling process takes place in the air and the wool falls in a light fluffy state. It is stated that a ton of slag produces approximately a ton of wool which has a high market value at the present time. In re-working the slag the company also recovers from 15 to 18 per cent ferromanganese which was not secured in the first process of melting the original ore. This product also is sold.



—Courtesy The Tacoma Daily Ledger

Tests Show the Quality of Core Oils

Tests Used by Manufacturers of Core Oil To Determine Character of Various Ingredients Are Described — Effect of Core Oil Varied by the Use of Dry or Wet Sand

BY R. F. HARRINGTON

AN INCREASING demand for thin metal sections in castings, notably in the construction of high-speed internal combustion engines, has brought the problem of cores and core binders into prominence. The old binders, flour, resin, molasses, and sour beer—have been found to be inadequate, principally because of the uncertainty of their binding properties, but partially because the intricate nature of cores requires new properties. The old binders are rapidly being replaced by specially prepared mixtures which are far more uniform in binding quality. These new binders may be divided into two general classes. The one, oil binders which are compounds of linseed oil and other vegetable oils and resin, and the other, moisture absorbing binders made of corn products, of byproducts of paper mills, of sulphite or other materials. On all intricate core work the oil binder has replaced other types to a great extent. However, that dry binders have their place in modern foundry practice is shown by the fact that thousands of tons of this material are used yearly.

The purpose of this paper is to point out some of the problems in connection with the manufacture and test of core oils, rather than to compare relative values of binders in the two classes. Linseed oil for many years was the standard of the oil binders. In fact, today many foundrymen still use it, though they are few compared to the number employing the compound oils which have linseed oil as a base. Molders have been inclined to look upon the efforts of the core oil manufacturer as an endeavor to manufacture a cheap substitute. That this is a false impression is shown by the fact that compounded oil is frequently superior in many respects to the natural product. The real effort of the manufacturer has been to produce a product specifically adapted to the making of cores. Core oil manufacturers have outgrown the criticism which fell upon their early efforts and their ability to eliminate linseed oil from the field almost everywhere demonstrates the merit of their products. An advance in the manufacture of core oils has been possible through constant study and experimentation, both in the foundry and in the laboratory.

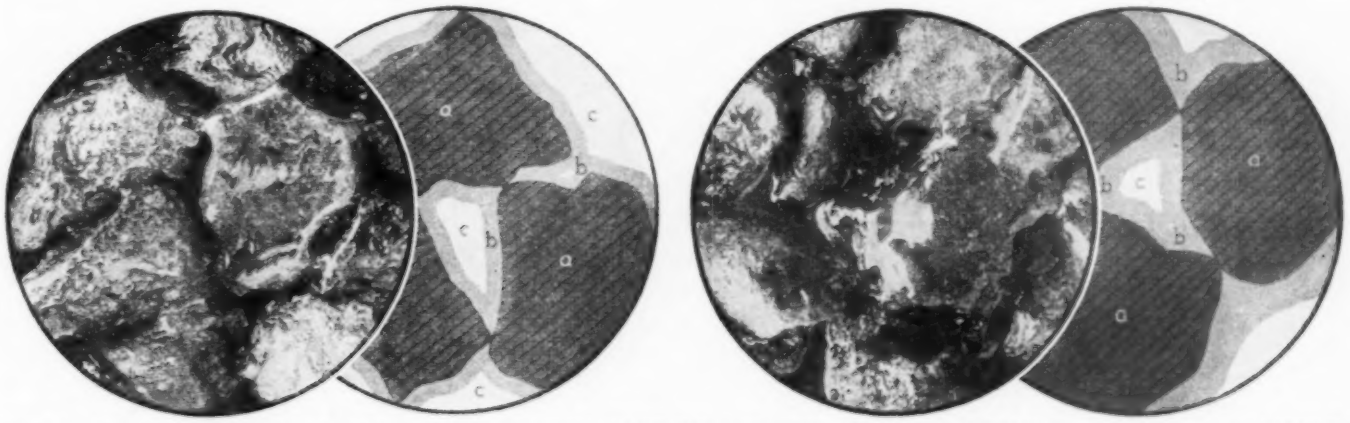


FIG. 1—MAGNIFIED VIEW OF SAND COVERED WITH CORE OIL—AT THE RIGHT A SECTION IS SHOWN AS IT WOULD LOOK IF CUT THROUGH THE GRAINS FIG. 2—A VIEW SIMILAR TO FIG. 1 BUT WITH TOO HEAVY A CORE OIL

Properties of Core Oils

Demands upon core oil are exacting. It must be of such viscosity as to mix well. That is, it must completely cover each grain of sand. It must have good binding qualities, so that a minimum amount of oil will give cores of proper strength. It must dry quickly; this is important where large production is demanded with minimum core oven capacity. The binder also, must dry evenly and thoroughly to the center of the core. It must not give off smoke or fumes injurious to those working in its vicinity. The function then of the core oil is to cover each grain of sand with a thin film which solidifies in the oven, cementing grains of sand together at the point of contact. Voids between the grains offer a passage for the escape of gases produced when the metal comes in contact with the core. It is therefore important that these voids are not filled up. In brief, the result desired in a core oil is maximum strength with maximum venting qualities.

From the foundry standpoint, a core must stand up under handling. If it is to remain in the mold for any considerable time, it is essential that it does not collect moisture. Neither must it soften or wash. Yet, after the setting of the metal, the core must crumble in order that it may be easily removed from the casting. Core oil should generate a minimum of gas when the hot metal is poured on to it.

Fig. 1 shows a few grains of sand in a core made with a good core oil. To the left they are shown as they appear under the microscope. On the right is a drawing showing the grains, film and voids as they would appear if they could be sawed through the centers of the grains of sand. In this drawing the letter *a* represents a grain of sand, while *b* represents the film of oil and *c* the unfilled void. It may be seen that the film completely covers each grain of sand and the capillary attraction has drawn the oil to the points of contact. It may be understood from this that clay or loam in

From a paper presented at the New England Foundrymen's association May meeting. Mr. Harrington is metallurgist for the Hunt-Spiller Mfg. Corp., Boston.

the core sand will prove injurious. It will take up space between the grains of sand, which should be left open for venting and furthermore it will retain large quantities of oil between the sand grains where it is not needed. This means an increase in the amount of oil which it is necessary to use to properly bind the core. The viscosity of a core oil is important. An oil of heavy viscosity is difficult to mix thoroughly and evenly with the sand. If a thorough mix cannot be obtained, there will be weak spots and strong spots. The hot metal will eat in at the weak spots and wash away the sand. The strong spots are often more serious than the weak ones, for here an excess accumulation of oil will often clog the air spaces, and thus confine the gases. The oil manufacturer tests the core oil for viscosity with a viscosimeter. This instrument measures the relative flow of water and the oil under consideration, through a standard orifice.

When an oil has too heavy a viscosity, the condition resulting is something like that shown in Fig. 2 which may be compared with Fig. 1, and shows the use of a large excess of oil. Too light a viscosity also means difficulties. In such a case, the oil mixes readily with the sand but when dried the coating is so thin that the joints are weak and the core crumbles and allows the metal to wash or cut in. The so-called dry binders usually require artificial venting, and the reason for this is sometimes explained from the fact that the binder material reduces the venting space between the grains of sand.

One of the best ways of determining the binding properties of a core oil is to make up a briquet and test it on a standard cement-testing testing machine. Such a machine is shown in Fig. 3. Shot from a container drops on to the scales until the core breaks when the flow of shot is automatically shut off. The weight of the shot thus dropped gives the proportionate load on the test specimen. The test is valuable only when a large number of briquets of an identical nature are used, so as to arrive at an average breaking weight. The transverse test on a rectangular bar is preferred by some. The specimen is supported on knife edges and the weight is applied in the middle. A 1-inch square bar is most frequently used with supports six inches apart.

FIG. 3—TESTING MACHINE USED FOR BRIQUETS MADE OF CORE SAND WITH A BINDER TO SHOW TENSILE STRENGTH

Other tests are used to determine the amount of smoke thrown off from the ovens in baking cores, the volume of gas given off by the core while in contact with the metal, and other properties. Many interesting facts have been revealed by recent tests. One of these is that poor linseed oil cores mixed at the ratio of 1 to 65, and baked six hours at 350 degrees Fahr. generated over 200 per cent greater quantity of gas than a high grade compound core oil. Soya bean oil cores generate over 100 per cent greater quantity of gas than cores made with linseed oil or more than 300 per cent greater than prepared core oils. A core containing 17.4 cubic centimeters of linseed oil generates 322 cubic centimeters of gas or 1850 per cent of the original volume.

Coremaker's Problems

While the manufacturer of core oil uses tests extensively to determine the effects of various oils, the consumer as a general rule does not thoroughly test the core oil he uses. In the writer's opinion, the user should apply tests to determine the relative merits of the oils which are submitted by producers. These tests may be conducted in the laboratory of the plant, if a laboratory is available, or may be performed on a small scale in any convenient place. In order that the tests thus performed may give accurate knowledge as to conditions, it is necessary to consider some of the difficulties which are apt to crop out in routine testing. Assuming uniform grain size and character in all tests, the moisture content is of prime importance. No other element will so affect the accuracy of results obtained as far as the character of the core is concerned. This is because wet sand means less sand when measured on a volume basis. In other words dry sand packs closer than wet sand in a given container. Thus the two measured volumes may be equal, yet because one is wet, and the other dry, there is less sand in the wet sample than in the dry sample. The effect of moisture on volume can be measured by taking a 1000-cubic-centimeter graduate of dry sand; moisten this with 100 cubic centimeters of water or 10 per cent by volume. This will give a new volume. This increased volume varies with different sands. An increase of 350 cubic centimeters or 35 per cent was obtained on local Wareham sand. Therefore it is not difficult to see the marked effect of different moisture conditions on the strength of cores. In the case of the dry sand, there are more grains to cover and thus the core would be weaker with the same amount of oil. Transverse tests were made on twelve bar-shaped cores, 1-inch square, placed on supports 6 inches apart, as previously described. In mixing the sand and oil for these tests oil was applied at the ratio of 1 to 40 on dry sand and the bars stood an average load of 24 pounds. When the same ratio of oil was used on a wet sand, the test averaged 33 pounds or an increase of 37.5 per cent. This has a direct bearing

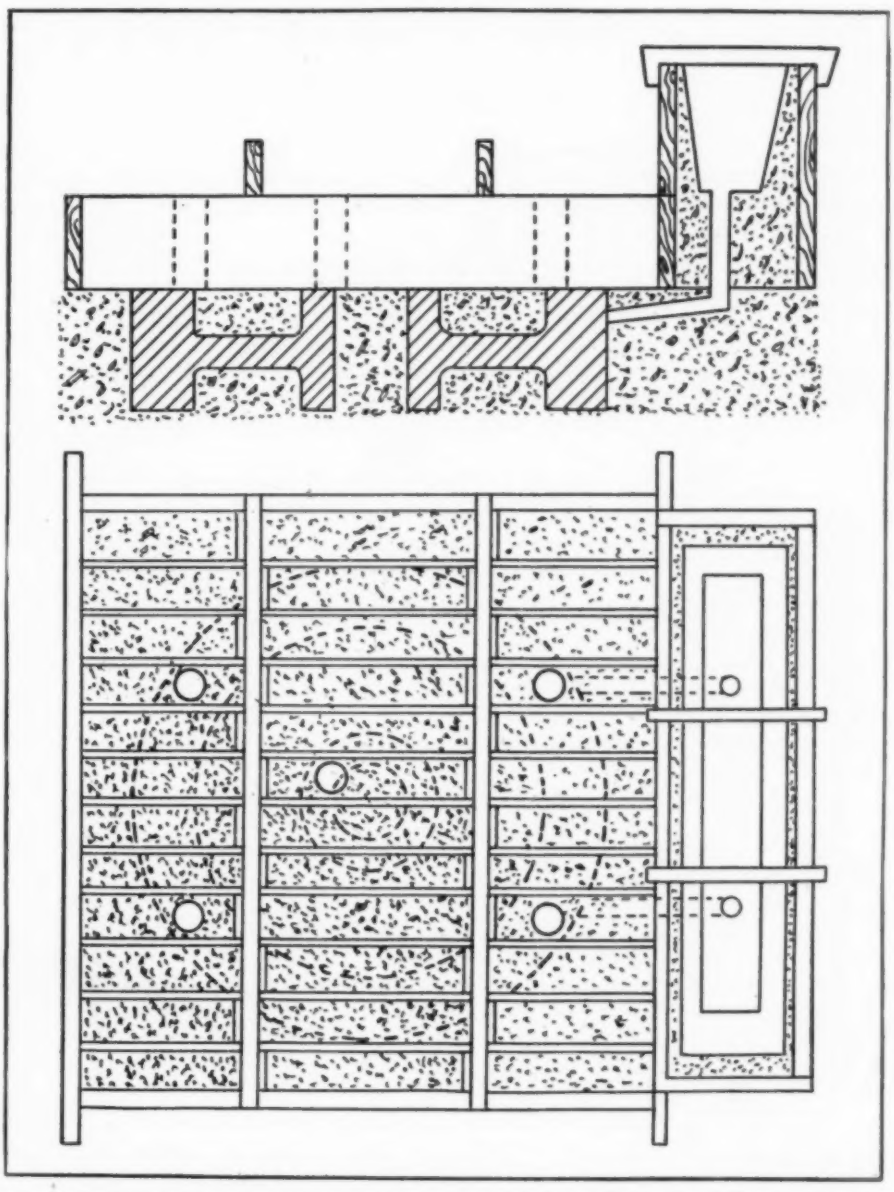
Making a Big Job in a Small Shop

The Molding Problem Presented No Particular Difficulties—Lack of a Suitable Ladle To Pour the Casting Was the Only Serious Feature To Be Considered

BY GEORGE BOYS

ABOUT 25 years ago while working in a small shop in Bathurst, New South Wales, Australia, I made a casting under rather unusual conditions. The plant, comprising a machine shop, foundry and pattern shop, was conducted by two partners, one a blacksmith and the other a patternmaker. The foundry force consisted of one helper, who attended the cupola and did odd jobs around the place, one apprentice and myself. We made plow points, architectural work, castings for the quartz crusher plants in the neighborhood, and general jobbing castings up to a few hundred pounds in weight. The flywheel on a road engine employed in digging a water main on Russel street broke one day and I suggested to the partners that they apply for the job of replacing it. They were as ambitious as I to establish a reputation and upon my assurance that we could handle it they did so. The nearest foundry at which repairs could be effected was at Sydney, 150 miles away, and when the road engine company telegraphed for an estimate they were told that under the most favorable conditions the wheel could not be replaced under two weeks. Our company promised to deliver the wheel in one week and on the strength of that promise secured the order. The accident was rather serious, holding up as it did the entire job, and time was the most important consideration. The original wheel was about five feet in diameter and provided with six arms. To simplify the job and eliminate pattern making I decided to make the wheel with a web center. In this way I could make the mold with two sweeps, one to form an outline on which to ram the cope and the other to form the cavity in the drag. We had no crane, but I swung a block and tackle from a suitable beam and dug a hole immediately underneath the block in which to make the mold.

While I was engaged in digging the hole, setting two iron flasks to serve as anchors, placing the cinder bed and in general preparing the hole for the job, the patternmaker was busy making the sweeps and checking them against a full-size layout drawing, and the blacksmith at the same time made an arm for the spindle and had it bored out in the machine shop. After setting the spindle seat and spindle the hole was filled with sand and rammed flush with the floor. The first sweep was then attached to the arm and a bed swept corresponding to the shape of the joint side of a pattern had one been employed. Parting sand was spread over the surface, after which the cope was set on and rammed in the usual manner. It then was hoisted off with the block and tackle, finished overhead and allowed to hang suspended. The hole was dug approximately to the shape of the desired lower half of the mold, after which the second sweep was attached to the spindle arm, lowered into place and employed to impart the proper shape to the sand. By working all night I had the mold finished at closing time on the fol-



THE POURING BASIN SERVING AS A RESERVOIR HELD ENOUGH IRON TO POUR THE ENTIRE WHEEL AT ONCE

lowing day. As a precautionary measure I built a fire in the bottom, lowered the cope down to what I considered a safe distance, then enclosed the sides with pieces of sheet iron and let the mold stand over night. The following day the cope was lowered into place and bolted down to the two copes previously referred to.

Pouring the casting was the most troublesome feature in connection with the job. The cupola was quite small and melted slowly and in addition the largest ladle in the shop had a capacity of only 300 pounds. As the estimated weight of the wheel was 1200 pounds I was confronted with a pretty problem. I disposed of the ladle feature by building a large runner basin in the shape of a reservoir large enough to hold all the iron required in the casting. A cubic foot of gray iron weighs about 540 pounds, so by making a runner basin 4 feet long, 1 foot deep and 1 foot wide at the top and 6 inches wide at the bottom I provided a capacity of 1350 pounds or 150 pounds over the estimated weight of the casting.

To expedite melting the iron we ran a 3-inch pipe from the blacksmith shop to the cupola to act as an auxiliary. The forges in the blacksmith shop were shut down temporarily while the blast was on the cupola. When all was ready we charged the cupola and put on the wind. The iron came down in good shape. We first filled the 300-pound ladle and lifted it over close to the runner. Then we filled two 200-pound ladles and poured the contents of all three ladles into the runner basin. The openings leading down to the gates were closed by a pair of cast iron stoppers. The 300-pound ladle was filled and dumped into the reservoir three times, thus giving us a sufficient quantity of iron to pour the casting exclusive of the risers, gates, etc. To insure an ample supply in case of accident or miscalculation the 300-pound ladle was filled again and set on a pair of horses close to the basin. The 200-pound ladle was set under the spout of the cupola.

The 300-pound ladle was lifted and dumped into the reservoir after a portion of the iron had been allowed to run into the mold. The 200-pound ladle was brought over, but it was not needed. Two of the risers were arranged as flow-offs and these took care of the surplus iron in the reservoir. The following morning the rim was stripped to equalize the cooling strain and then the casting was allowed to remain in the sand all that day and night. The machinists required a day and a night to do their part, but in spite of all the drawbacks the wheel was in place and the engine running inside of seven days after receipt of the order.

Sewer Ring Castings Made in Open Sand

BY M. E. DUGGAN

FOR some unexplained reason the sewer ring which forms the top of the manhole almost universally is made with a flare on the sides which makes it imperative to lift the body of sand forming the inside before it is possible to draw the pattern. In addition to the flaring sides many of these rings are provided with an internal flange near the lower edge on the inside. The purpose of the flange is to support the manhole covering when the casting is in place in the street. One of these rings as it was designed in the first place and as it afterward was changed to facilitate molding is shown in the accompanying illustration. In Fig. 1 is shown a broken piece of the ring in section. The pattern was made to mold in the position shown, the inside down to the internal ring to be lifted out. The inside of the pattern down to the parting line was made almost straight. It was made in the way the drawing called for and seemed perfectly satisfactory to the draftsman and, for that matter, to the patternmaker. However, when the pattern reached the foundry it was promptly rejected and branded as all wrong. If only one or two castings were ordered it probably would have gone through, but in this case the order called for 500 castings and therefore the foundry wanted an economical type adapted to repeated operation. Before taking up the manner in which the pattern was changed it is not out of place to comment further upon the pattern as originally constructed. The inside was made to lift out and yet the draftsman allowed no taper, when he might just as easily have allowed a quarter of an inch or more. A special cope flask was needed for every mold to support and secure the body of sand forming the inside of the mold. Irrespective of whether the molder employed a lifting plate, an arbor or a set of long chuck bars fastened to the cope, the process was bound to be slow, since a man could not make more than about three castings a day. The design of this pattern was changed as shown in Figs. 2 and 3 so that the entire mold was made in the drag and poured in open sand. Besides saving the cost of a set of cope flasks this method also did away with the time and labor incident to ramming a set of

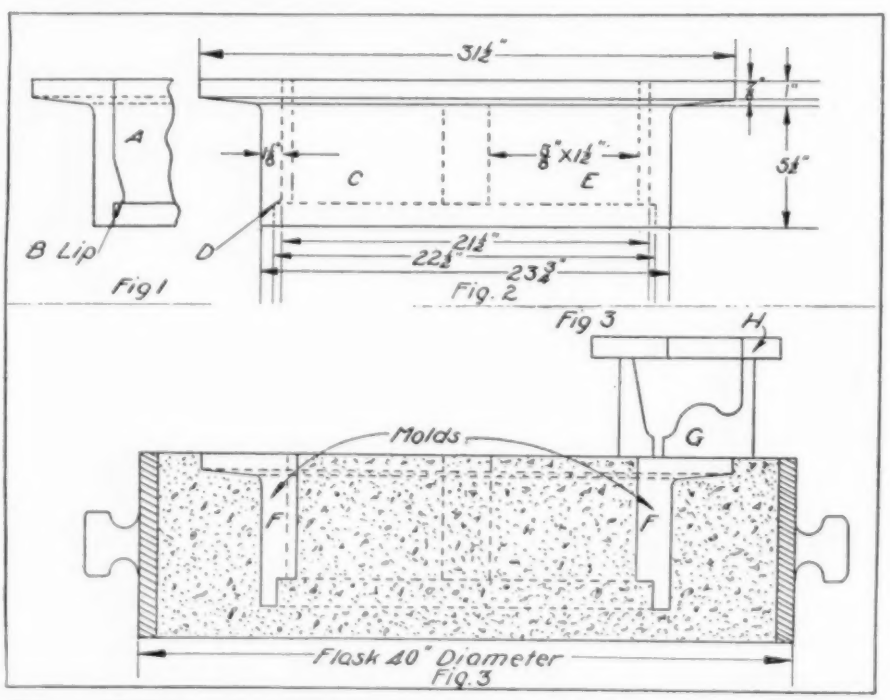


FIG. 1—SECTION OF PATTERN AS ORIGINALLY MADE FIG. 2—PATTERN CHANGED TO MOLD ENTIRELY IN THE DRAG FIG. 3—SECTION THROUGH CENTER OF MOLD READY FOR POURING

these flasks every day. In addition, where the first method required the services of a highly skilled workman, this method was well within the scope of any intelligent laborer; and last but not least the production was increased to 14 castings a day. If some form of molding machine had been available this production could have been materially increased. The objection probably will be raised by some person that the upper surface of the casting will be rough and unsightly. Admitting this to be true, what is the difference so long as the castings produced in this way answer the purpose for which they were intended? The casting is inverted when in use and the rough upper surface is set into concrete or brick.

The altered pattern is shown in Fig. 2 with the internal ring removed. In its place a recess, *D*, has been provided to support the cover casting. Four strips, two of which are indicated at *E*, Fig. 2, form auxiliary supports and insure that the cover will not tip over or fall down inside the frame.

In preparing one of the molds a round flask 40 inches in diameter is leveled on the foundry floor. Sand is shoveled in approximately to where the bottom edge of the pattern will rest. The pattern is lowered in and adjusted until the upper surface is flush with the upper flange of the flask. Sand then is shoveled into the flask and rammed until it has been filled to the top. A straightedge is employed to scrape the top level, after which the pattern is drawn out of the sand and a runner core placed over the flange in position for pouring as shown at *G* in Fig. 3.

Two alternative methods might be employed on this job, depending upon local conditions. In the first two long rails could be laid in the floor and adjusted perfectly level and parallel. Then a number of drags the exact height of the pattern could be set on these rails. By filling sand between the rails and scraping it level each morning it is evident no further leveling of the pattern would be required. The flasks as well as the castings could be lifted each night, thus affording opportunity to cut over the sand heap. On the following morning, after the sand between the rails had been attended to, the flasks could be returned to their places with the assurance that they would be perfectly level.

The other method involves the use of a plain jolt-ramming machine. In addition to the drags it would be necessary to supply a number of bottom boards. In this case also a pair of long rails bedded in the floor would be quite a help in leveling the drags. They could be leveled individually, but a permanent level bed would expedite matters.

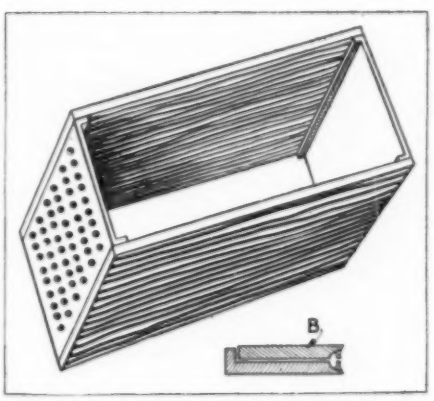
Simple Rig for Molding Iron Sash Weights

BY J. M. FACKLER

IN RESPONSE to a request for an economical method for making sash weights which appeared in a recent issue of THE FOUNDRY I submit the following which I used many years ago. The castings are molded and poured horizontally, the patterns are not split and no copes are employed on the flasks. The number of flasks required will depend on the proposed output and the inside dimensions of the flasks will depend on the range of sash weight sizes. The following directions may be regarded as those for a typical unit.

Make a flask with at least one iron end, this end to be perforated with rows of 1¾-inch holes spaced about 3 inches apart. Then turn up a sufficient number of round sticks 1½ inches in diameter to fill at least three rows of holes. These sticks should be long enough to make the longest weight required and still extend past the open end of the flask at least 6 inches. Suitable marks on the patterns would indicate how far they should extend inside the flask to make weights of varying sizes. Instead of round wooden patterns it may be advisable to fit up pieces of 1½-inch pipe. They will last longer and are preferable in every way.

To make a mold with this rigging, the flask first is set approximately level on the foundry floor. Sand is shoveled in and rammed to a height corresponding to the bottom of the lowest row of holes. A row of patterns then is inserted in the lower row



SASH WEIGHT FLASK HAS PERFORATED IRON ENDS—CUT-OFF CLIP AT *B*

of holes, the distance they are shoved in determining the weight of the resulting sash weight. A long ½-inch square stick is set up vertically in the sand behind and touching the end of each pattern. A course of sand is shoveled in and rammed and then a second row of patterns is inserted in the second row of holes. They are shoved in until the end comes into contact with the upright runner sticks. The second row of patterns is rammed and then a third row is treated in a similar manner. After the third row has been rammed the lower row can be pulled out through the holes in the end of the flask.

These patterns then are placed in the fourth row of holes and this sequence is kept up until all the holes have been utilized. After the last row of patterns have been pulled out of the flask the square sticks are drawn after a basin has been cut to facilitate pouring the metal.

The little clip shown at *B* in the illustration is employed to stop off the end of the mold where it comes through the end of the flask and also serves to make the eye in the end of the weight besides leaving an impression designating the weight of the casting. These clips are made of cast iron turned to 1½-inch diameter and slightly tapered toward the eye end.

One clip is needed for each hole in the flask. They are shaken out with the castings and with ordinary care will last indefinitely. When the iron flows into the weight and fills the eye it expands the clip slightly. This tightens the clip in the mold and prevents the iron from running out through the holes in the flask.

Sash weights made in this manner will have no fins and will be perfectly round. If a flask is poured short it only means one row of molds. It always is possible to come along later and finish pouring the remaining mold in the flask. Instead of a shoulder at the end of the clip they may be doweled together, but dowel pins and holes have a tendency to weaken these castings and if they must be used they should be kept back as far as possible from the eye. It is self evident that it does not require skilled labor to make sash weights with this rigging.

The International Nickel Co. has removed its offices to 67 Wall St., New York city.

THE FOUNDRY

Registered U. S. Patent Office

A semimonthly journal devoted to all branches of the foundry trade

Published by
THE PENTON PUBLISHING CO., CLEVELAND

BRANCH OFFICES

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FOREIGN OFFICES

BIRMINGHAM, Eng.....Prince's Chambers
LONDON, Eng.....2-4 Caxton House, Westminster

Cable address, IROTRAPEN, London.

SUBSCRIPTION

United States and Mexico.....$3.00 a year
Canada.....$4.00 a year
Great Britain and other Foreign Countries.....$5.00 a year
Single Copies.....25 cents

Copies published three months or more previous to date of current issue, 50 cents each

ADVERTISING

All communications relating to advertising copy, discontinuances, etc., must be received on the 1st and 15th of the month preceding date of publication.

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Chart Tells a Comprehensive Story

KEEPING in close touch with foundry operations is difficult for the superintendent of a large foundry or the general superintendent of a works of which the foundry is only one of several units, unless charts are used. Reports of course will enable the superintendent to keep in touch with operations, if the reports are complete and are studied by him. However, comprehensive charts tell at a glance how the foundry is functioning and how its operations at any one time compare with those of another date. Thus progress or deterioration are indicated. The specific department of the foundry responsible for any decrease or increase in efficiency also often may be detected through a glance at the charts, if they are complete enough. Percentage of defective castings figured in weight and in number of castings will tell an illuminating story if the defects are classified as to causes such as cold shut, blow, draw, internal shrinkage, misplaced core, etc. These may be divided into foundry scrap and machine shop scrap. Then, when the scrap of a day is compared with the composition of the metal, the condition of the coke and possibly with the temperature of the iron as it came from the cupola intelligent deductions may be made. Charts are kept readily on boards sliding in a case, probably a half dozen or more deep, and this arrangement forms a compact file of information.

Fuel Oil Bids for Foundry Favor

WIDE changes in the price and supply of fuel oil present a problem to many foundries operating oil-burning equipment. A few years ago after a period of cheap oil in which time a large number of oil-burning furnaces and annealing ovens were installed in foundries the oil supply was overtaxed and the oil interests urged manufacturing companies to change the equipment of their furnaces to burn coal as they said the oil supply would dwindle and be entirely inadequate for the manufacturing needs. However, cheap oil came again and there was a plentiful supply for all needs. Later, notably in the past year or two, the price of oil not only went up, but it became difficult and at some times impossible to obtain the required supply of fuel oil. Now oil again is cheap enough to offer inducements for its use in the foundry; but in a number of plants powdered coal installations have been made which involve such a high installation charge that oil never could supplant the powdered coal. In some cases where hand-fired coal is used, there is an opportunity for oil to regain its former place or to even extend its field. A study of the economic side of the question would pay the foundrymen in general because a possibility exists of transforming a furnace or oven from coal or coke burning to oil fired units at a comparatively small cost. Frequently this can be done with a little change in the brick work and the introduction of a burner. Of course, in addition to the change in the furnace storage capacity for the oil, a compressor and pipe line would have to be installed; but even with this it might pay to have the equipment changed. If the price of oil again became excessive the change back to coal could be effected with a small alteration in the brick work of the furnace and the oil-burning equipment could be held in readiness for use.

Trade Outlook in the Foundry Industry

MAY has taken its place with April and February in industrial history, marking the low level of business activity. Economists point to this continued inactivity as one sure evidence of improvement to be found immediately ahead. It is pointed out that the continuation upon this low plane of manufacturing activity and the slackening in price recessions indicate that the bottom of the curve has been reached and the turning point is not far ahead. Easing credits support this assumption.

Bottom Reached

Foundry operations throughout the entire country remain at about the same percentage of normal capacity as has been noted during the past two months. In the New England district, the average is given at about 33 per cent of normal, with some below this figure and a few above. Through the Central West operations range about 25 per cent of normal, when those shops which are entirely closed are omitted. In the South, particularly in the Birmingham region, an improvement is noted. A slight betterment in the demand for cast iron pipe and a sustained volume of orders for sugar mill machinery has brought this about. The financial situation in Cuba has served to hold back some of the latter business, but this has been compensated in a measure by orders from Mexico and from domestic sugar refiners. In New England, a bright spot has been noted in the growing demand for textile machinery notably from China. The first of seven large cotton mills recently was shipped to that country by a Massachusetts firm and further business is pending. With the exception of this encouraging sign, foundry production in this district presents no features.

Prices of Raw Materials for Foundry Use

CORRECTED TO MAY 23

Iron		Scrap	
No. 2 Foundry, Valley	$24.00	Heavy melting steel, Valley	$12.00 to 12.50
No. 2 Southern, Birmingham	22.50 to 23.00	Heavy melting steel, Pitts.	13.50 to 14.00
No. 2 Foundry, Chicago	22.50 to 24.00	Heavy melting steel, Chicago	11.50 to 12.00
No. 2 Foundry, Philadelphia	24.50 to 26.00	Stove plate, Chicago	15.00 to 15.50
No. 2 Foundry, Buffalo	25.00 to 26.00	No. 1 cast, Chicago	16.00 to 16.50
Basic, Valley	22.00 to 22.50	No. 1 cast, Philadelphia	18.00 to 19.00
Basic, Buffalo	25.00 to 26.00	No. 1 cast, Birmingham	13.00 to 13.50
Malleable, Chicago	23.00	No. 1 cast, Buffalo	18.00 to 18.25
Malleable, Buffalo	25.00 to 26.00	Car wheels, iron, Pittsburgh	15.00 to 15.50
Coke		Car wheels, iron, Chicago	14.50 to 15.00
Connellsville foundry coke	$ 4.50 to 5.25	Railroad malleable, Chicago	14.00 to 14.50
Wise county foundry coke	6.50 to 8.00	Agricultural mal., Chicago	14.00 to 14.50
		Railroad malleable, Buffalo	11.50 to 12.50

Hope for Railroads

Continued pressure to secure an adjustment downward in freight rates, up to the present has not been successful. However, encouraging features are noted in the railway situation. High wages have been blamed by the railroad management departments as the one great obstacle to reducing rates. A decision looking to the reduction in pay of unskilled railroad employes is taken as a forerunner of similar reductions in all classes of railway labor. In this event, there is little doubt but that economies may be effected which will remove all logical objection to freight reductions. Many believe that this is the greatest single factor to be overcome in bringing about better industrial and business conditions. An instance of the manner in which freight rates bear directly upon the foundries was given recently in THE FOUNDRY in a discussion of the increased cost of sand. Since that time, the American Sand association appealed to the interstate commerce commission for a readjustment and reduction in rates. The railroads are buying but few castings, as practically no new equipment is being purchased and repairs are cut down to an absolute minimum. An improvement in freight movement is slowly bringing about an increase in revenues to the roads, and consequently their buying power is increasing. Malleable shops which specialize in railway work are on part time schedule and report that the companies are buying only for their immediate needs.

Automotives Slacken

The improvement in operation of automobile factories, which was noted recently shows indications of being short lived. The impetus was accepted as an indication of seasonal demand, and this belief has been strengthened during the past few weeks. Recent price recessions in well known makes of passenger cars have not been effective in stiffening the lagging demand, and some of the larger plants again are faced by part time operation. The revival did little to assist the foundries as it was found that the stock of castings which remained from last season and which had remained in the yards of the foundries or in the shops of the manufacturers were by no means depleted. Implement makers have practically ceased production. The buying power of the farming communities has been almost entirely eliminated, through falling crop prices and restricted credit. It is expected that much lower prices for implements will have to obtain before better business can be expected. Stove and furnace foundries in many sections are more fortunate than those in the same localities which are engaged in other lines. This particularly is true throughout those regions where the decrease in the supply of natural gas has brought about the general installation of new heating units. Demand for sanitary ware is sporadic. A few of the larger interests continue to manufacture for stock, although building conditions at the present time do not supply a steady outlet for their products. Building construction in many of the larger centers has been hampered through labor disputes, but falling prices in materials and the urgent housing need is taken to indicate a rapid revival. Almost all building inaugurated this spring has been confined to dwellings, as few large office or industrial structures have been undertaken. This character of construction carries with it the need for the various castings which are required in the extension of public utilities lines.

New York metal prices based on quotations in the *Daily Metal Trade* of May 23 follow: Casting copper, 12½c; Lake copper 13.25c to 13½c; lead, 5.00c; antimony, 5.25c to 5.37½c; Straits tin, 33.25c to 33.50c; aluminum, No. 12 alloy, producers' price, 27.30c and open market, 18.50c to 19.50c. Zinc is 4.80c to 4.85c, E. St. Louis, Mo.

Comings and Goings of Foundrymen

FRED M. FEIKER, vice president of the McGraw-Hill Co., Inc., New York, has been appointed assistant to Secretary of Commerce Hoover. Mr. Feiker, who is one of the best known men in the business paper field, will assist the department of commerce in effecting a contact with industries and the country's business. In furthering this work Mr. Hoover is holding monthly conferences with the National Conference of Business Paper Editors. Mr. Feiker was graduated from Worcester Polytechnic Institute in 1904. For two years he was in the technical department of the General Electric Co. and since that period he has been actively identified with various business paper publishing houses.

Fred W. Moser has resigned his position as general superintendent for the Newark Stamping & Foundry Co., Newark, O., a position which he had held seven years.

E. R. Swanson, formerly with the Duquesne Steel Foundry Co., Pittsburgh, is now president of the Keokuk Steel Castings Co., Keokuk, Ia.

Robert M. Leach, treasurer of the Weir Stove Co., Taunton, Mass., has been elected president of the National Association of Stove Manufacturers.

T. A. Lavelle, of the Lavelle Foundry Co., Indianapolis, has been elected a director of the William Small Co., Indianapolis, manufacturer of automobiles.

Clark W. Hollister recently has become connected with the Cleveland Flux Co., Cleveland. Mr. Hollister formerly was connected with the Basic Mineral Co., Pittsburgh.

Edwin Wilson, president of the Connecticut Electric Steel Co., spoke on "The Electric Furnace" before the Hartford, Conn., section of the American Society for Steel Teating, May 12.

John W. Rayburn, superintendent of the Cleveland Co-operative Stove Co., Cleveland, has resigned to accept a similar position with the Channon-Emery Stove Co., Quincy, Ill.

R. F. Harrington, metallurgist, Hunt-Spiller Corp., South Boston, Mass., addressed the regular May meeting of the New England Foundrymen's association on the subject of core oils.

Frank J. Lanahan, president of the Fort Pitt Malleable Iron Co., Pittsburgh, was elected to membership on the board of trustees of Carnegie Institute of Technology and of Carnegie Library to succeed the late Henry Kirke Porter.

Homer J. Forsythe, manager of the construction division of the engineering department of the Du Pont Co., Wilmington, Del., has been transferred to the position of assistant general manager of the Hyatt Roller Bearing Co., Newark, N. J., a subsidiary of the General Motors Corp.

R. W. Valls, vice president, the Champion Engineering Co., Kenton, O., has taken charge of the newly established Columbus office of that concern. Erwin B. Philips, who for some time has been works manager, has been placed in charge as general manager at the office and works in Kenton.

Henry T. Gerdes recently was elected president of the Hauck Mfg. Co., Brooklyn, N. Y. Mr. Gerdes, who succeeds the late Arthur E. Hauck, is a graduate of Stevens Institute of Technology and for many years was manager of the Treadwell Engineering Co., Easton, Pa. The other officers of the company are: M. C. Hauck, A. B. Hauck and H. H. Kress, vice presidents; A. H. Stein, treasurer and J. Lutz, secretary.

Joins Business Exchange

John J. Swann recently has resigned his position with the Prest-O-Lite Co., Indianapolis to become associated with the Engineering Business Exchange, 30 Church St., New York. Mr. Swann for a time was one of the editors of *Engineering Works* and later was connected wiith the Ingersoll-Rand Co., the Longmead Iron Co., the Chicago Pneumatic Tool Co., Keller Manufacturing Co. and the American Arms Corp.

Addresses Members of the Chicago Club

At a largely attended monthly dinner meeting of the Chicago Foundrymen's Club held in the City Club rooms on the evening of May 14, Pat Dwyer, engineering editor of THE FOUNDRY, spoke on topics connected with foundry operation. He reviewed in considerable detail modern cupola practice with special reference to losses occasioned through ignorance and careless supervision. He also spoke at some length on the selection and preparation of molding sand. In the discussion which ensued it was proposed that some of the points brought up by Mr. Dwyer be made the subject of a series of papers to be presented jointly at the first fall meeting in September. The meeting in June will be largely of a social nature; the meetings in July and August will be passed as usual and then an aggressive campaign will be instituted at the September meeting to embrace and enroll all foundrymen in the Chicago district as members.

Welding Society Elects

S. W. Miller, Rochester Welding Works, Rochester, N. Y., was elected president of the American Welding society at the organization's annual meeting in the Engineering Societies building, New York. Other officers and directors chosen at the same meeting follow: Vice President, C. A. McCune, Page Steel & Wire Co., Monessen, Pa.; A. S. Kinsey, Stevens Institute of Technology, Hoboken, N. J.; E. M. T. Ryder, Third Avenue Railway Co., New York; E. Wanamaker, Chicago, Rock Island & Pacific railway, Chicago; J. C. Lincoln, Lincoln Electric Co., Cleveland; W. T. Bonner, New York Shipbuilding Co., New York; H. R. Swartley, Davis Bournonville Co., Jersey City, N. J.; D. B. Rushmore, General Electric Co., Schenectady, N Y.; H. L. Nicholson, Westinghouse Airbrake Co., Wilmerding, Pa.

First Two of Sly-Fanner Bandits Condemned

Frank Motto was found guilty by a jury in common pleas court in Cleveland, May 14, of murder in the first degree in the killing of Wilfred C. Sly, president of the W. W. Sly Mfg. Co., Cleveland, and George K. Fanner, superintendent of the same company, on Dec. 31 last. Motto was immediately sentenced by Judge Florence E. Allen to die in the electric chair on Aug. 29. Sam Purpera, a second member of the gang, was found guilty May 20 and will be executed on the same day as Motto. The two company officials were shot to death by a gang of bandits on the railroad bridge at W. 47th street and the Nickel Plate tracks as they were carrying the payroll to the Sly company plant.

Obituary

Victor E. Tresise, vice president and secretary the Ohio Pattern Works & Foundry Co., Cincinnati, O., died at his home in that city Tuesday, May 3.

Henry M. Sovereign, 85 years of age, of Whitehouse, N. J., a retired iron foundryman, died at that place May 7 after a long illness. He was born at Stanhope, N. J. Many years ago he purchased a machine shop and foundry at Pottersville, N. J. In 1900 he moved to Lebanon, N. J., where he erected a plant and continued in the foundry business until a short time before his death. He is survived by his widow and four children

William Bradford Hathaway, vice president and manager of the Boston office of the Barstow Stove Co., Providence, R. I., died in a Boston hospital recently, aged 71 years. He had been identified with the stove industry since 1876, at one time being president of the Smith & Anthony Co., Boston, which was liquidated in 1916. Since that time he had been connected with the Barstow Stove Co.

Charles H. Morse, one of the founders of Fairbanks, Morse & Co., died May 5 at Orlando, Fla., after an illness of two months, aged 88 years. He was born at St. Johnsbury, Vt., Sept. 23, 1833, and after finishing his academy course in 1850, entered the employ of E. & F. Fairbanks & Co., scale manufacturers. After advancing in this employment, he went to Cincinnati in 1863 and established the house of Fairbanks, Morse & Co. He moved to Chicago in 1869 and later became president of the company.

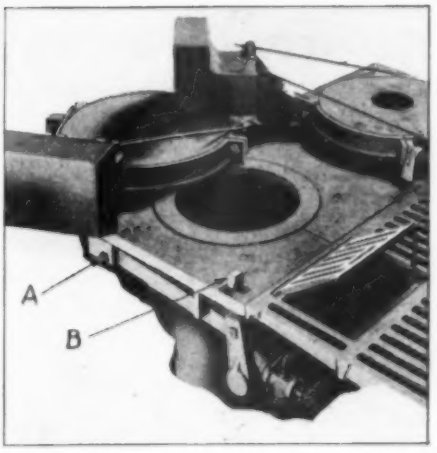
Thomas L. Smith, founder, director and chief stockholder of the T. L. Smith Co., died Friday, April 29, 1921, at his home in Milwaukee. Born in England, June 6, 1855, he came to this country with his parents at the age of four, received his early schooling at St. James Episcopal school, Milwaukee, and while still a boy, moved to Watertown, Wis., where his father had established a machine shop and foundry. In his father's shop he learned the machinist's trade. In 1873 he entered Iowa State College, Ames, Iowa, and was graduated in 1877. During his four years at Ames he acted as instructor in the college machine shop. He completed his engineering education in the Massachusetts Institute of Technology. The early part of his career, immediately following his college life, was spent in drafting and engineering work with some of Milwaukee's large manufacturers, including Allis-Chalmers Co., Filer & Stowell Mfg. Co., Pawling & Harnischfeger Co., C. J. Smith & Sons Co. and Kempsmith Mfg. Co. D J. Murray Mfg. Co, Wausau, Wis., manufacturer of logging machinery, also employed him as chief engineer. During this period, he invented the first really successful wood-carving machine. In 1899 Mr. Smith's invention of the Smith tilting concrete mixer took definite form and the first machine was manufactured in 1900. Later he took out patents and built additional machines. With assets of only $500 in 1900, the business grew so rapidly that in 1905 Mr. Smith organized a corporation known as the T. L. Smith Co., which today has assets of over $1,200,000. Later he purchased the Sterling Wheelbarrow Co., West Allis, Wis., and within a few years developed that business to the point where it was one of the largest and most successful of his holdings at the time of his death. The Smith Engineering Works, Milwaukee, manufacturer of rock and ore crushers, is another company organized and developed by Mr. Smith.

BATTERY OF FURNACES AT NORFOLK YARD

Navy Pit Furnaces of Novel Design

In the description of the new foundry of the Norfolk Navy Yard, appearing in the May 1 issue of THE FOUNDRY, mention was made of the battery of pit furnaces employed for nonferrous melting. Twenty-two of these furnaces, connected to a common stack, are so constructed that they may utilize either coke or oil fuel. Each of 20 of the furnaces will accommodate No. 150 crucibles while false linings are constructed to adapt the two remaining to No. 80 crucibles.

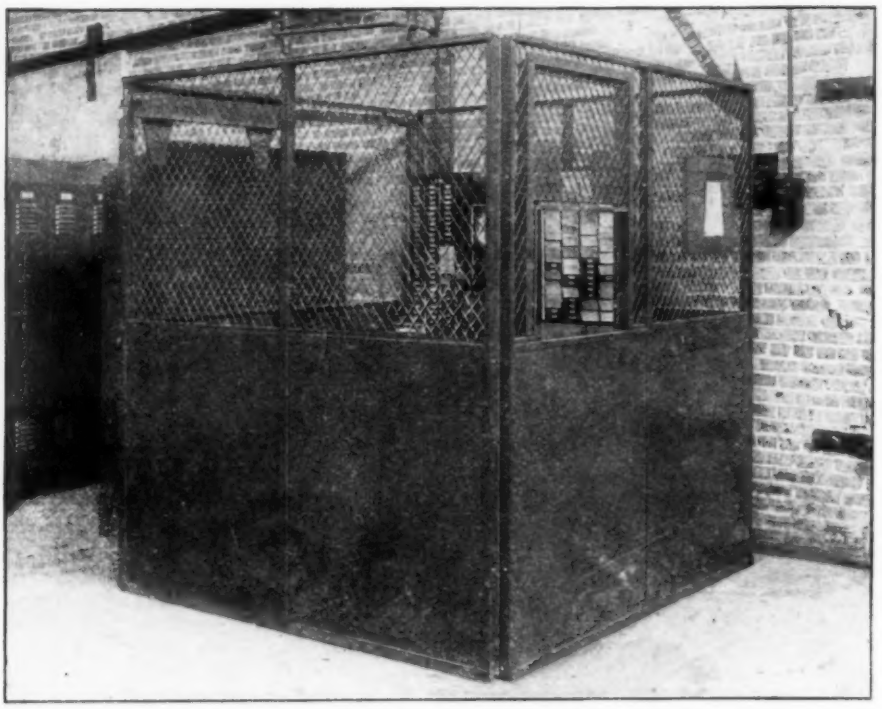
A novel feature of the installation is noted in the covers for the pits, shown in the accompanying illustrations. These are interchangeable, merely by replacing the fireproof caps contained within the cast rings as shown. When coke is used a tight joint is necessary in the cover, and this need has been met by a special lifting mechanism which may be noted at the right. The cover and its counterweight at the rear rest solidly upon a cast-steel pin, slotted at its lower extremity. This pin rides a lifting bar, which is bolted to a rigid fulcrum only a short distance from the lifting pin. The bolt is shown at *A*. The lifting bar, in turn, is provided with a counterweight, and a vertical foot-lever, shown at *B*. A pressure of 15 pounds on the foot lever, lifts the bar at the opposite end, carrying the pin and the superimposed cover and counterweight. The cover then may be swung around upon the pin as indicated.



LIFTING RIG ON FURNACE COVERS

Hand-lift traps in the grating in front of the furnace permit of easy access to the oil-firing control mechanism. Drop grates, operated from the ground level are lifted, when it is desired to substitute coke fuel. The equipment was designed and installed by the Foundry Equipment Co., 1831 Columbus road, Cleveland.

The Conshohocken Iron & Steel Co., Conshohocken, Pa., has completed the installation of a large grinding plant for grinding ferromanganese, ferrosilicon, chrome, manganese ores and other materials. With the original mill, the new equipment gives this plant a capacity of approximately 50 tons per day.



THIS BOOTH IS BUILT UP FROM SECTIONAL STEEL PANELS

Designs New Time Booth

For the use of factory timekeepers, department foremen and other employes who require inclosed offices or booths, the Lyon Metallic Mfg. Co., Aurora, Ill., recently has designed a small booth. As shown by the accompanying illustration, this booth is built from standard sectional panels which may be fastened together to give the desired size of inclosure. One section is provided with a sliding window for passing time checks or papers back and forth.

Welding a Press Flange

A large punch press frame, part of which when taken from the sand proved defective, while not a particularly difficult job of welding was one of considerable magnitude and presented a real problem to the foundryman. The casting weighed 16 tons and represented a value of $1800 in material and labor.

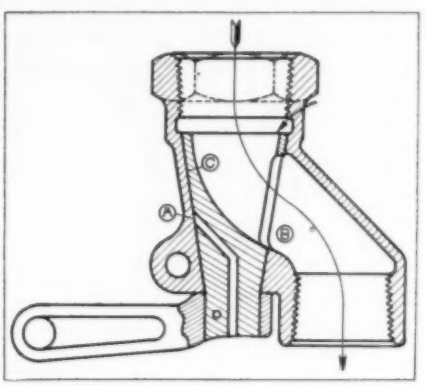
The foundry was equipped with oxygen welding apparatus and the local operators were familiar with the process. However, on such an exceptionally large job it was deemed expedient to enlist the aid of the service department which is maintained by the Oxweld Acetylene Co. for the benefit of its customers. The casting was honeycombed at the point marked *A* on one side over an area of 20 square inches and to a depth of 1¼ inches. On the opposite side it was necessary to build up a flange corresponding to *B* on the side shown, 4 feet long, 8 inches high and 2½ inches thick, along lower edge.

Fortunately the character of the repairs required only local preheating and they were in such a position that it was not necessary to move or turn the casting during the entire welding operation. Two operators were employed and nearly 200 pounds of No. 9 cast-iron rod was used as a filler.

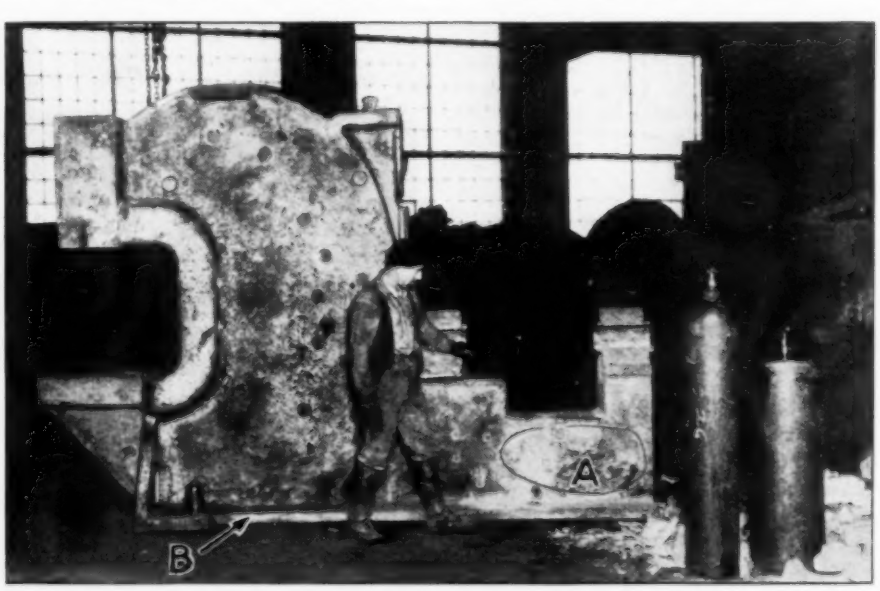
New Air Valve Invented

To eliminate air losses through leakages in compressed air lines as a result of the destructive action of the air upon the valve seats, a new valve has been developed in which the air does not come in contact with the seat. The air pressure is utilized as the seating agent to hold the plug on its seat. As shown by the accompanying illustration, the device consists of three parts, the body, plug and handle. By using a hollow taper plug, with the large end uppermost, the air enters at the top, passes through the valve and out of an opening in one side of the hollow plug into the supply chamber which connects directly with the air hose. Thus the air does not come in contact with the seat.

The long arrow shows the direction of the air in its travel through the wide unobstructed air passage of the valve. The short arrow indicates the point on the large end of the plug where the air pressure is forcing the taper plug constantly against the walls of the valve body to form a tight seat. A unique waste arrangement allows the accumulated pressure in the air hose to escape to atmosphere when the valve is shut off as shown by the air ports *A* and *B*. This device prevents scale or grit blowing into the face of the operator when he disconnects the hose from the valve. The valve is manufactured by the Cleveland Pneumatic Tool Co., Cleveland.



PRESSURE OF THE AIR RETAINS THE CLOSE SEATING OF THIS VALVE



A HONEYCOMBED AREA WAS RECLAIMED AND A FLANGE BUILT ON

Interest in Equipment Still Torpid

Slight Improvement Noted in the Eastern Section—Demand for Cranes and Heavy Machinery Is at a Minimum, Following Slight Pickup of Past Weeks

WITH the exception of a slight improvement in inquiry for foundry equipment from the East, the market is at a standstill. Present foundry operations fail to sustain the demand even for the sundries which are required in everyday service, and new projects are exceedingly scarce. A few high spots are noted, such as the continued purchase of equipment by the Ford Motor Co., and export demand has served to bring up the average output of some manufacturers.

Demand Shows Improvement in the East

SELLERS of foundry equipment in the East report an improvement in demand. It is slight, but of the kind that is conducive to better confidence throughout the market. It is not based on one or two large inquiries, or orders, but on scattered business, foundries generally showing more interest than they have in some time. There are also a few new foundries in prospect which are a factor in the better feeling now prevailing. Among the larger buyers at this time is the Lutz Co., Philadelphia, which is buying equipment for a new foundry addition, including a 10-ton electric crane, with 40-foot span, placed with the Case Crane & Engineering Co., Columbus, O. Another is the Chapman Valve Co., Indian Orchard, Mass., and the Indiana Foundry Co., Indiana, Pa. This latter concern recently purchased a 3-ton single, I-beam crane, with 15-foot span, from the Shepard Electric Crane & Hoist Co., Montour Falls. The Fords Foundry Co., Perth Amboy, N. J., has temporarily abandoned its project. The National Hoisting Engine Co., Harrison, N. J., has broken ground for a new gray iron foundry.

Quiet Prevails in Pittsburgh

WITH foundries in the Pittsburgh district operating on an average around 25 per cent of capacity, the market for foundry equipment remains devoid of feature. Some sellers report a decided falling off in demand and state that even foundry supplies are not moving. An almost total lack of demand exists for flasks, core ovens, etc. Molding machine manufacturers, however, are somewhat encouraged due to the receipt of several inquiries which give promise of business as soon as industry revives. A real revival, however, is not anticipated until fall. The Henry R. Worthington Pump & Machinery Corp. purchased a molding machine unit recently for its Harrison, N. J. plant and a southern steel plant contemplates a complete layout at an early date. The Herman Pneumatic Machine Co. has just completed the installation of two 40 x 124-inch jar stripping plate machines and one 40 x 124-inch rollover machine at the Milwaukee plant of the International Harvester Co. to make tractor frames. Cranes find no ready sales at present among foundries in this district. The Ohio Brass Co., Mansfield, O., has purchased a 5-ton 38-foot span crane from the Milwaukee Electric Crane & Mfg. Co., Inc., Milwaukee.

Ford Buys Cleaning Equipment in Chicago

MOST foundries in the Chicago district have insufficient business to keep them at all busy and as a result are not in need of equipment or supplies. The future looks better than the present to most equipment men and some inquiry is coming into the market looking to later needs. This is noticeable in molding machines, and some producers find considerable inquiry, especially for rollover units of medium capacity. Inquiry along this line is decidedly better than it has been. The only important transaction recently seems to be the sale of 24 tumbling barrels of special design by the Whiting Corp., Harvey, Ill., to the Ford Motor Co. These barrels supplement others of the same type previously installed. Little else is noted except sales of some ladles and other small equipment needing frequent replacement. Building of new foundries is held in abeyance largely because of difficulties in financing. Even the present lower prices of building materials are not attractive, as it seems likely present prices will be discounted further, and inasmuch as the need is not pressing, most projected plants are being held up.

What the Foundries Are Doing

Activities of the Iron, Steel and Brass Shops

Fire recently damaged the plant of the Ronan Bronze Works, Brooklyn, N. Y.

The W. B. Bearings Co., 441 South Eleventh street, Newark, N. J., recently was organized.

The American Foundry & Mfg. Co., Frederick, Md., is reported planning to enlarge its foundry.

The Home Hot Blast Furnace Co., Grand Rapids, Mich., is erecting an addition to its plant.

Ground has been broken for the erection of a gray iron foundry for the National Hoisting Engine Co., Harrison, N. J.

Hillis & Sons, Halifax, N. S., whose plant was recently damaged by fire, is reported planning the erection of a modern foundry building.

Erection of an addition to its plant is being planned by the Thacher Propeller & Foundry Corp., Albany, N. Y.

The Midway Foundry & Machine Shop, Burlington, N. C., is reported planning the erection of a plant building, 40 x 100 feet.

The plant of the James P. Sutton Steel & Structural Iron Foundry, New Orleans, recently was damaged by fire.

Contracts have been awarded by the Fay Foundry Co., St. Joseph, Mich., for the erection of an addition to its plant.

Plans are being drawn for the erection of a pattern shop at Rushville, Ind., for the Dill Foundry Co., Indianapolis.

Contract for the erection of an addition to its plant, 50 x 80 feet, has been awarded by the Jenkins Mfg. Co., 20 Vesey street, New York, manufacturer of valve and brass goods.

The Monarch Pattern Works, Detroit, has purchased a site on which it is reported planning to erect a plant.

The Kahler Sprinkler & Brass Mfg. Co., 367 Fair Oaks avenue, Pasadena, Cal., recently was organized by William T. Kahler, and others.

Capitalized at $16,000, the Chicago Chaplet Co., Inc., 1925 North Paulina street, Chicago, recently was incorporated by Henry Bellon, Herman Bellon, and others.

Capitalized at $5000 the Interstate Foundry Specialties Corp., New York, recently was incorporated by S. H. Cleland, H. A. Wright,

V. T. Rowland and J. T. Crane, 2 Rector street.

Capitalized at $100,000, the Master Valve Co., Ltd., Toronto, Ont., recently was incorporated by Alexander H. Lightbourn, Irene Rouse, and others.

Capitalized at $10,000, the Exchange Foundry Co., Chelsea, Mass., recently was incorporated by Max Winograd, Nathaniel P. Sears, Hyde Park, Mass., and H. L. Goodman.

Contracts have been awarded by the Lutz Co., Philadelphia, for the erection of an addition to its foundry. It is reported buying some additional equipment.

The Fords Foundry Co., Perth Amboy, N. J., has acquired a site for a plant, the first unit of which will be 70 x 162 feet, with an extension, 30 x 50 feet.

The Haus Iron & Bronze Works, San Francisco, has been incorporated by Otto Seipel, M. Haus and Charles J. Johnson, Claus Spreckels building.

The Canada Iron Foundries, Ltd., Ft. William, Ont., is reported planning the establishment of a wheelmaking plant to be operated as a subsidiary of its present plant.

The Bierwith Pattern Works, 51 West Hancock street, Detroit, plans the erection of a 1-story factory building at Marysville, Mich., to be 40 x 100 feet.

Erection of an addition to its plant, 72 x 130 feet, is being planned by the John E. Mannen Co., 2241 St. Clair avenue, Cleveland, furnace manufacturer.

The Motor Valve Mfg. Co., 737 South Grand avenue, Los Angeles, has been organized to manufacture engine valves, etc., by W. N. Rathburn, and others.

The Wilmington Brass Foundry, Wilmington, Cal., has been organized to manufacture brass and bronze products, by F. J. Breen, R. J. Coan, and others.

Capitalized at $1,300,000, the Piston Valve Corp., New York, recently was incorporated by C. H. and T. H. Matthesson and W. G. Brown, Woolworth building.

The Storage Heater & Furnace Co., Highlands, N. J., recently was incorporated with a capital stock of $300,000, by G. V. and Harry N. Johnson and William Koch, to manufacture furnaces, etc.

H. Smith, D. E. Morris, and others, have been named as the incorporators of the Smith Foundry & Machine Works, Gulfport, Miss., which was recently incorporated with a capital stock of $50,000.

The Ferguson Mfg. Co., Ltd., London, Ont., has been incorporated with $40,000 capital stock, as iron, steel and brass founder, by Charles H. Ivey, Samuel E. Weir, John C. Elliott, and others.

A new foundry is being built at Fords, N. J., by a company headed by Owen Canfield, of Matawan, N. J. Operations are expected to be started the latter part of June. The foundry building will be 70 x 162 feet.

The Springfield Bronze Co., Springfield, Mass., has been incorporated with a capital stock of $50,000, by Joseph R. Gould, Leonard Johnston and Robert S. Kneeland, Longmeadow, Mass.

The Henry Furnace & Foundry Co., Indianapolis, is reported planning the construction of a storage building in the rear of its present plant at 915 North Davidson street. The building will be 2-stories.

The Smarts Breckville Furnaces, Ltd., Breckville, Ont., has been incorporated with a capital stock of $100,000, to manufacture furnaces, stoves, etc., by James Arnold, John H. A. Briggs, David R. Fowler, and others.

The Atlas Die Casting Co., Inc., Worcester, Mass., has been organized with a capital stock of $100,000, by Arthur M. Brewster, president; Malcolm F. MacNeil, 25 Brighton avenue, Boston, treasurer, and Allan Robinson.

The Calumet Malleable Iron Co., 9651 Torrence avenue, Chicago, has been incorporated with a capital stock of $50,000, by Francis Mead, M. J. Boyle, George R. Baker, Thomas E. Duffy, T. J. Fell, and others.

The Sandwich Foundry, Ltd., Sandwich, Ont., recently was incorporated to manufacture iron, steel, castings, forging, machinery, etc., with a capital stock of $200,000, by Frederick W. Fretter, Elton Rogers, William L. Mayberry, and others.

The Corundo Steel Co., Ltd., Montreal, Que., has purchased the old Record Foundry & Machine Co.'s plant at 17 Mill street. The new owners will establish a plant here for the manufacture of cutting and precision tools from low grade steel.

The Highway Crossings, Ltd., Toronto, Ont., has been incorporated to carry on business as iron founder, machinist, engineer, etc., and to manufacture crossing equipment, machinery, etc., with a capital stock of $50,000, by Lillian Dillon, Ritta Hatton, and others, as provisional directors.

The Inland Iron Works, Inc., Joliet, Ill., has taken over a plant at 101-109 McDonough street, and will in addition to manufacturing pumps and engines, engage in general jobbing foundry work and machine shop operation. The plant is fully equipped for the manufacture of gray iron, brass, bronze, copper and aluminum castings. I. W. Edwards is general manager.

Articles of incorporation have been filed by the Falk Corp. and the Falk Investment Co., which represent a development of the business of the Falk Co., Milwaukee, operating one of the largest open-hearth steel foundries in the Middle West and also manufacturing herringbone gears, pinions and oil engines. The Falk Corp. is capitalized at $8,000,000 and the investment company at $4,000,000.

To manufacture reversible pump valves, the Jerome-Rothenbucher Valve Co., 3136-3138 West Chicago avenue, Chicago, recently was incorporated with a capital stock of $60,000. The company at the present time has arranged for the manufacture of its products, being connected with the Hansen & Olsen Foundry Co., Chicago. It is the intention to erect a plant addition as soon as building conditions are more satisfactory. Officers of the company are: President, George C. Jerome; vice president and treasurer, G. E. Rothenbucher; superintendent of metal department, Oscar A. Hansen, and superintendent of production, George E. Olsen.

The Nitro Mfg. & Mine Supply Co., Nitro, W. Va., has purchased a site on which it will erect a plant. It is expected operations will commence in 60 or 90 days. The company is capitalized at $200,000 with the following officers: President, E. P. Bailey, Connellsville, Pa.; vice president, J. P. Necessary, Huntington, W. Va., and general manager, T. Redding, Fairmont, W. Va. The company will specialize in the manufacture of coal mining equipment, including tipples, chutes, various loading devices, mine cars, pumps, etc. Work has been started on the erection of a foundry building, 43 x 212 feet, and a machine shop, 75 x 400 feet. Muerling & Letchfeld, Nitro, W. Va., are consulting engineers.

New Trade Publications

FOUNDRY EQUIPMENT—Jolters, squeezers, pouring devices, stripping machines and other foundry equipment, are described and illustrated in a 4-page folder being circulated by the Arcade Mfg. Co., Freeport, Ill.

PORTABLE ELECTRIC TOOLS—The Independent Pneumatic Tool Co., Chicago, has published a 4-page folder in which portable electric drills, grinders, etc., are described and illustrated. One illustration shows an electric drill equipped with a new pistol grip handle, being used on a motor truck frame.

GRINDER—The Blanchard Machine Co., Cambridge, Mass., has published a 64-page data booklet, in which a grinder manufactured by the company is described and illustrated. Tpyical work done on this machine is shown. The last few pages of the booklet contain a partial list of users, and a list of parts ground.

MONORAIL HOIST—A small illustrated folder has been published by the Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., in which both floor controlled and cage operated electric monorail hoists are described and illustrated. The illustrations show the hoists in various occupations, both at inside and outside work.

FRICTION CLUTCHES—A new catalog describing friction clutches and dealing with some of the engineering problems involved in their use has been published by the Hanson Clutch & Machinery Co., Tiffin, O. In the booklet the applications of clutches to power requirements ranging from 1/6 to 1550 horsepower and at speeds ranging from 10 to 3000 revolutions per minute are described.

INDUSTRIAL PUBLICATION—Frank D. Chase, Inc., Chicago, is circulating the January issue of its publication *Industry*. This issue contains a number of interesting articles, among which is one by Frank D. Chase on "The Employer's Analysis of an Engineer." Valuable information is given in another article entitled "How to Get a Foundry That Fits," by L. M. Hansen. This article is accompanied with typical layouts of malleable, gray iron and steel foundries, with dimensions of yards, melting equipment, molding area and core rooms. Other interesting articles are given in the booklet which is of 32 pages.

CRANES—The Milwaukee Electric Crane & Mfg. Co., Milwaukee, has published a 48-page illustrated booklet in which electric cranes, hoists and horizontal drilling and boring machines are described and illustrated. Some of the leading features of the electric cranes, pointed out in the booklet are: All parts are strong, rigid and accessible; bearings are self-ciling and arranged so as to prevent the escape of oil and the entrance of grit and dust; bridge truck and trolley truck bearings are arranged for oil and wool waste lubrication; bridge end trucks are of structural steel with cast steel brackets, designed so that the load is evenly divided. A general description is given of the horizontal drilling and boring machine, which is designed to cover a wide range of drilling and boring and is said to be especially suitable for operating at one setting, on pieces too long or bulky for the usual type of machines. The booklet is profusely illustrated, showing actual installations of the cranes at various industrial plants.

LADLE DRIERS—The Mahr Mfg. Co., Minneapolis, is circulating a leaflet in which it describes and illustrates ladle driers for gray iron foundries. According to the folder, these driers will dry linings quickly, burning any grade of fuel oil, kerosene or distillate. They operate on compressed air at any pressure from 40 to 120 pounds per square inch. Complete specifications, etc., are given.

TORCHES—Large size, compressed air type foundry torches are described and illustrated in a folder recently published by the Mahr Mfg. Co., Minneapolis. These torches operate on compressed air at any pressure from 25 pounds to 120 pounds, according to the leaflet. Complete specifications are given.